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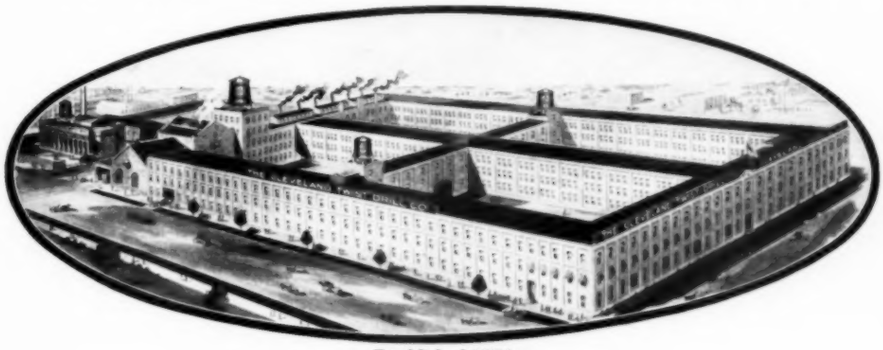

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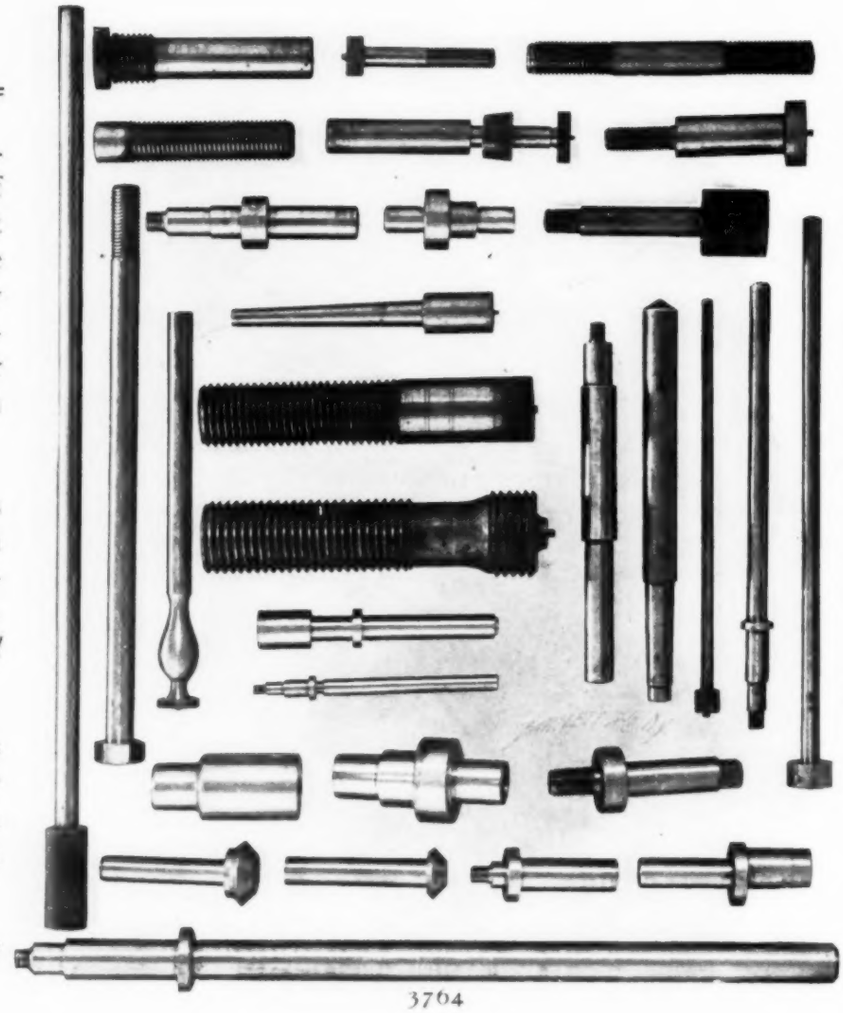

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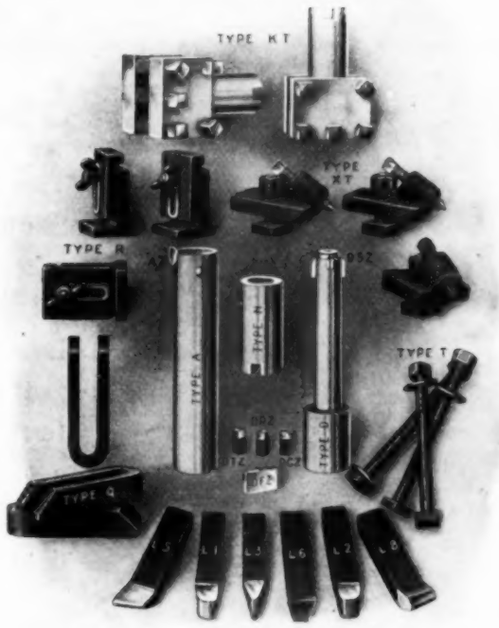


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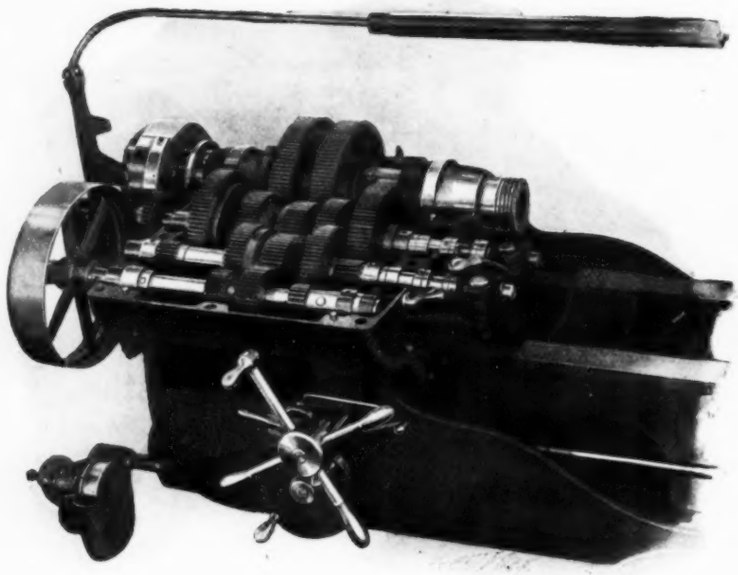

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# Precision Levels and Accurate Leveling

## Setting Boring-mill Uprights with a Novel Form of Level, and Leveling Planers Properly for Accurate Work by Suitable Appliances

## BY VARIOUS CONTRIBUTORS

The level as an instrument of precision is not generally understood in the machine shop. When two parts of a machine are to be set, one perpendicular to the other, and, as often happens, their relative positions are such as to make it inconvenient to measure with a square, I have found an accurate level mounted on a triangular frame, as shown in Fig. 1, to be a very useful tool.

Fig. 2 shows the method I have used for setting the uprights on a boring mill: First, the bed is leveled so that the top of the spindle is level, position 1 (the spindle top being used as the table is not as a rule in place at this stage); then, after the upright is set in position, the vertical arm of the frame is brought to bear on the face of the upright, as indicated in position 2, and the level will immediately show in which direction and to what extent the upright leans (forward or backward); and after one has become accustomed to the level one graduation indicates so much per foot. In the levels I have made I have used what is known as a four-second level, which will easily measure 0.00025 of an inch per foot.

While in Europe I had occasion to use a level of this kind and knowing Carl Richal (who is an expert on levels, having made the vials for the levels used on the Lick telescope), I submitted my drawings to him and he volunteered to get up a mounting that would not be affected by the difference of expansion between the vial case and the frame. Parts of the frame in Fig. 1 are cut away to show the method used. The caps at the end of the vial case are made of tool steel, one end terminating in a ball, the other in a parallelogram. The ball end is held in position by means of the cupped adjusting screw and a cupped spring pin. The other end rests on a rounded hardened steel surface held by a spring pin and gib and the side adjustment is made by the screw opposed by a spring pin. As will be noticed, no part of the vial casing is held rigid but is held in place by the spring pins opposite the adjusting screws.

A form of vial which I have found very convenient for such work is shown in Fig. 3. The vial has a partition across near the end which divides it into two compartments connected by a small hole near the bottom. The object of these two compartments is that the small compartment may act as a reservoir to store the surplus of air or liquid which enables

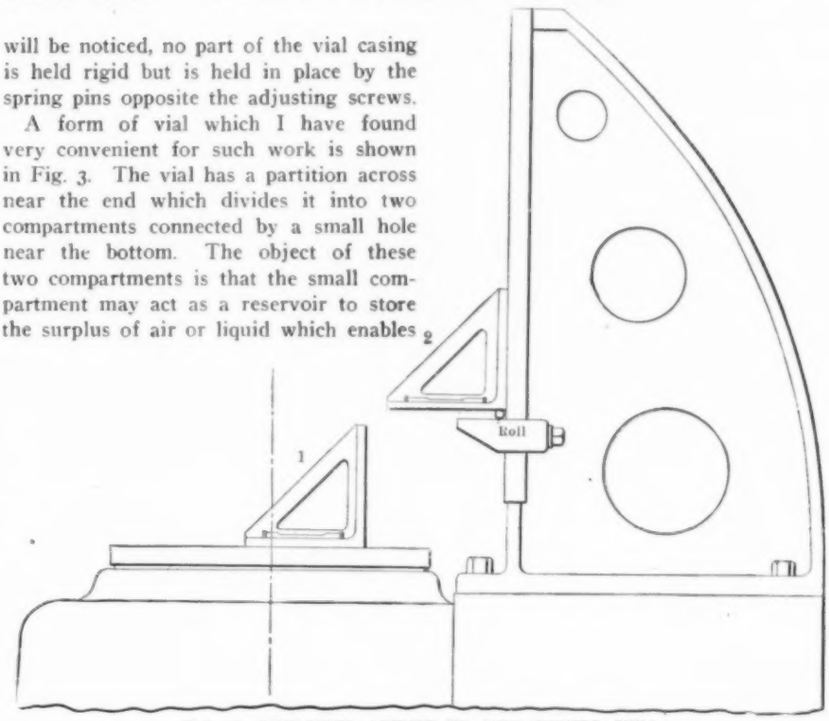


FIG. 2. THE LEVEL APPLIED TO THE BORING MILL

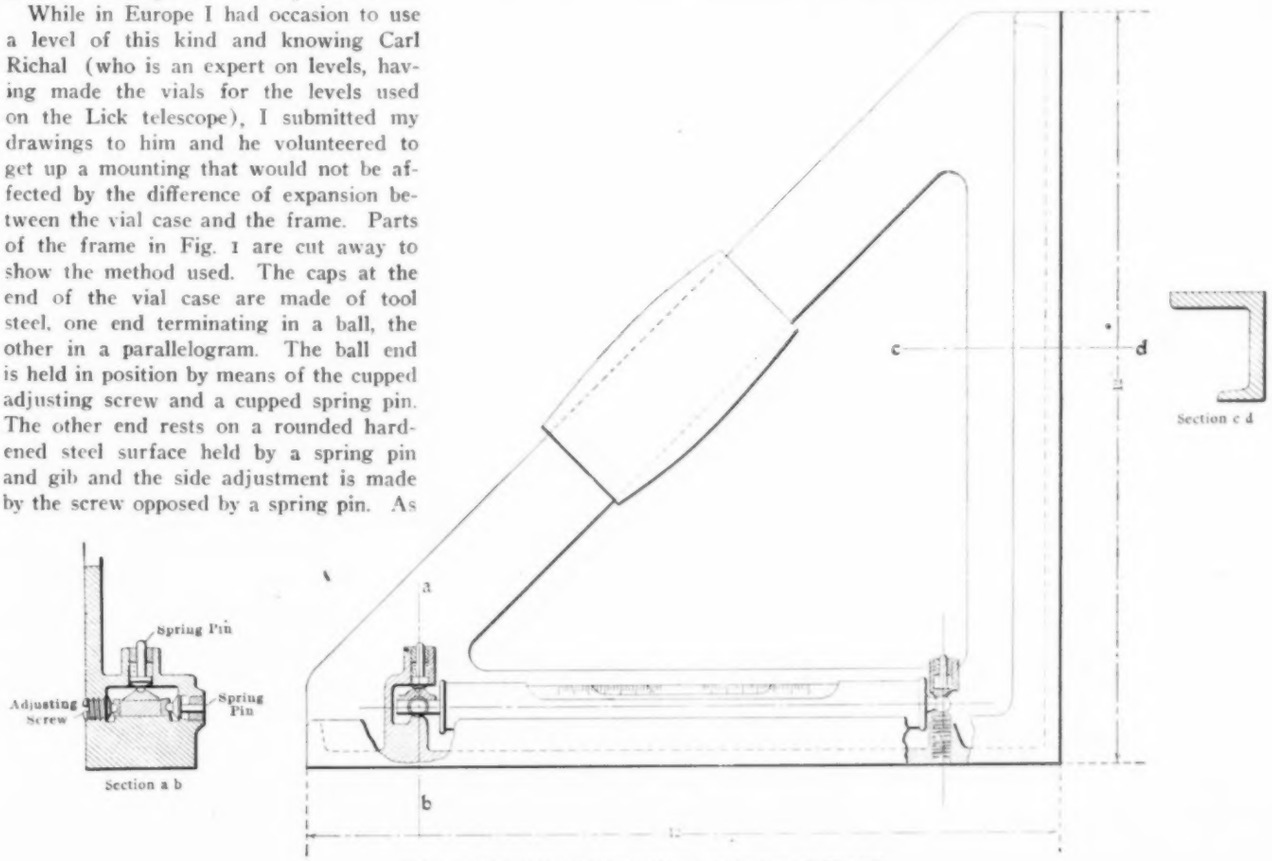


FIG. 1. PRECISION LEVEL WITH TRIANGULAR FRAME

one to reduce the bubble in the level chamber or increase it to its full limit. If the bubble has been reduced the surplus air will be in the small chamber and if the bubble is increased to its largest capacity the small chamber will be full of liquid. Supposing that the bubble is full size, it is reduced by tipping the vial on end, which brings the air space next to the small partition. This will allow the air to escape up into the small compartment, the liquid then going down into the larger compartment. This can be carried on to any degree required until the bubble becomes very small in the vial. The advantage of this arrangement is that with the bubble considerably reduced it is less sensitive to the slight vibrations that generally occur in a shop; also it is an advantage to be able to lengthen or shorten this bubble to cover exactly a certain number of lines on the graduated glass as the difference in temperature causes a slight variation. The accuracy of the level is not affected by changing the length of the bubble.

C. L. LIBBY.*

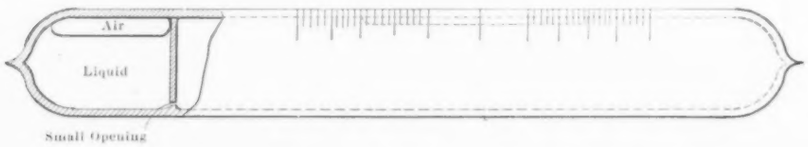


FIG. 3. VIAL WITH PROVISION FOR VARYING THE SIZE OF BUBBLE

## Leveling and Bolting Down Planers

We have read with interest the articles on "Leveling and Bolting Down a Planer," by various contributors and as the subject does not seem to be generally understood, we will briefly describe our method, which we have found very satisfactory.

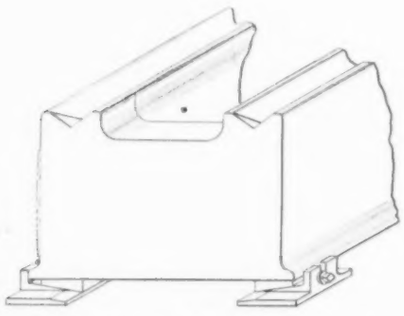

FIG. 5. LEVELING BLOCKS IN POSITION

Fig. 4 shows the style of leveling jack used under our own machines, and which we also try to have our customers adopt. The ledge on the base extends about ½ inch higher than the wedge when it is drawn up to the limit. In building a foundation we leave a hole about 14 inches square and 4 inches deep at the places where these leveling jacks are to go, then we place the planer on some wood blocks, laid across the foundation, line it up accurately with reference to the countershaft or line shaft, and level approximately. Now we place these leveling jacks in the openings in the foundation, set them so that the ledge extending up from the block is tight against the side of the bed or legs, as the case may be; we also put some pieces under the base to hold the jack up against the bottom of the bed, and having adjusted the jack so that it will leave enough movement to the wedge for final leveling, we are now ready to fill the opening with concrete. Filling up with a thin grout on the sides and in the two holes in the base plate, after leaving this to set over night, we take the temporary pieces from under the bed, and do our final leveling. This makes a very neat job both for appearance and convenience for re-adjustment, at any time, should the foundation settle or dry out more on one corner than another, which it nearly always does.

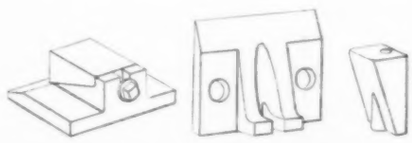

FIG. 4. A LEVELING BLOCK FOR THE PLANER

In answer to the statement that special drives, etc., put on top of the machine, make a machine unsatisfactory without bolting down, we want to say that we have built a great many variable-speed planers every month for the last five years. This variable-speed drive is put on top of the planer and in case of a motor drive the motor is also added on top. As there was, at first, some prejudice on this account we watched them very closely and always found them to work satisfactorily, after they were leveled properly.

With reference to the planers moving on the foundation, it has been our experience that this happens only in very rare cases and then on account of only two causes in a well built modern planer. The first is excessive high return speed, which is bound to give the machine more or less of a shock; the second is where extremely heavy cutting is done on work such as a number of bosses on a piece or any work that makes the cut intermittent. To overcome this we place the leveling jacks as shown in Figs. 5 and 6. It will be seen that the ledge of the jack is against the bed in four directions, and that it is impossible for the planer to move around without breaking the foundation; at the same time the planer may be releveled at any time without removing bolts, as would be necessary if it were bolted down.

Bolting down a planer that has been machined within a fraction of a thousandth, to a rough floor or foundation, is certainly giving it rough treatment. In the first place the holes in the legs on the bed are not put there for this purpose, as some seem to think, but for bolting to the skids to facilitate shipping; our foundation plans never show these holes or any bolts as referred to by Mr. Norton, at page 957, Vol. 30, Part 2.

All of us have seen floors, especially in the second and third story, that would sink ¼ inch or more when a heavy piece was rolled over them. You can readily guess what happens to a machine when it is bolted to a floor of this kind. When a planer has a tendency to move on a wood floor or temporary foundation, it is much better to bolt a piece of wood or iron against the side of the planer. On floors that change temporarily, due to a heavy piece being rolled past the machine, it is not advisable to use wedges. It is better to use flat pieces of iron and shim up with tin, then a small wood strip can be nailed against these flat pieces to hold them in place so that when the floor

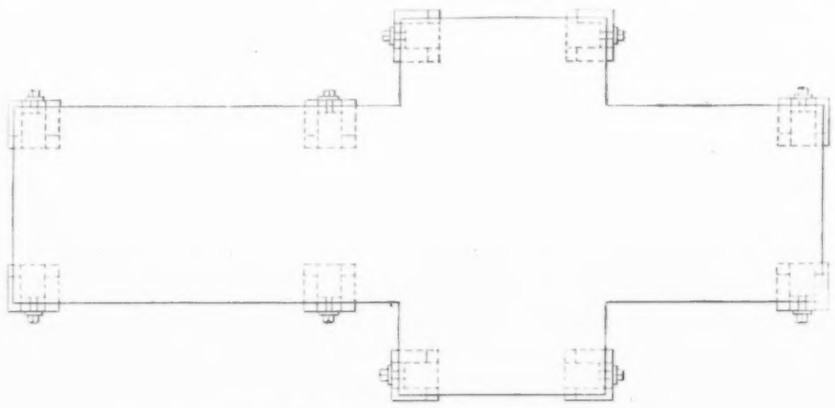

FIG. 6. ARRANGEMENT OF LEVELING BLOCKS UNDER PLANER

*Superintendent, International Machine Tool Company.

changes they will not work out, but will be in place when it comes back to its natural position.

G. LANGEN.*

## Testing and Using Planers in a Grinder Shop

Good planing will save many strokes of the scraper, and planing is very much cheaper than scraping. Building a grinding machine is a proposition where the workmanship, especially in the planing line, shows up very distinctly, and if the planing is good, produces an accurate tool; but when the slides and guides are poorly planed their value on this class of machines is much impaired.

In the shops of the Landis Tool Company a system of planing has been in use for some time, in which the best methods known to the company have been put forth to make the work of the planers above reproach. The first step toward good planing is having one set of planers to do the roughing and semi-finishing and another set to do nothing but refinish or skim, as it is sometimes called, the work that comes from the roughing machine.

In order to do good work on a planer, as anyone with knowledge of machine tools must know, the machine, like all other tools, must be properly cared for and the guides must be kept in perfect shape to insure an accurate job.

Fig. 7 shows a small planer, the guides of which are being tested with a spirit level, an operation which can be plainly understood as the standard plug gages, the level and the cross test bar can be easily seen. The level used here is worth a description, being a somewhat more elaborate affair than the ordinary carpenter's level generally used for lining up. It has a substantial iron base planed perfectly true, and the glass is graduated to read in thousandths of an inch, somewhat as in the sketch Fig. 8, in which the dotted line represents the bubble. These levels are regularly manufactured by some of the mathematical-instrument makers.

*Superintendent, Cincinnati Planer Company.

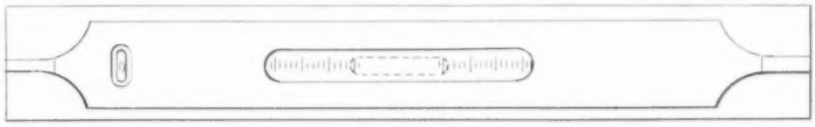

FIG. 8. PLAN OF LEVEL

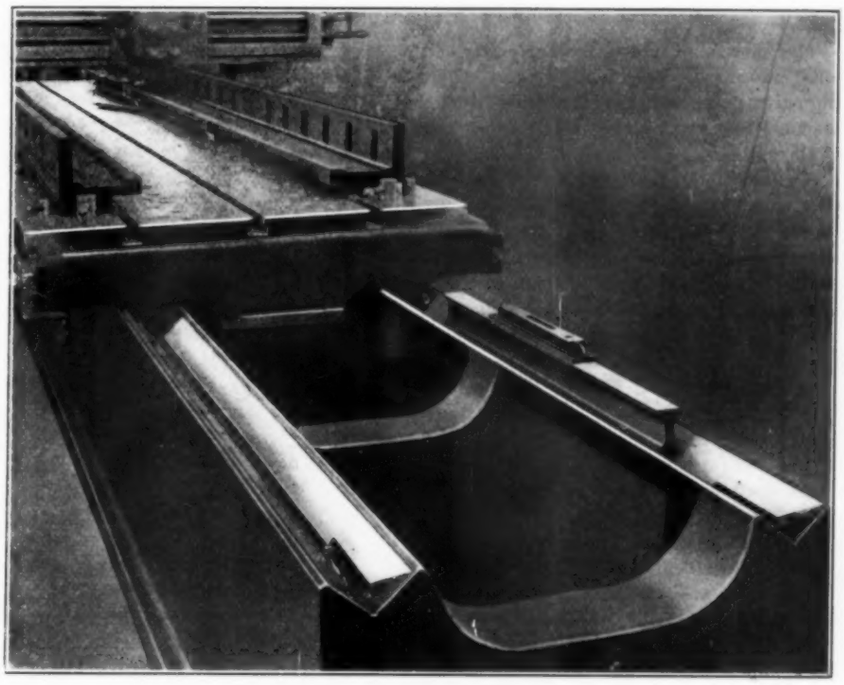

FIG. 9. TESTING PLANER WAYS

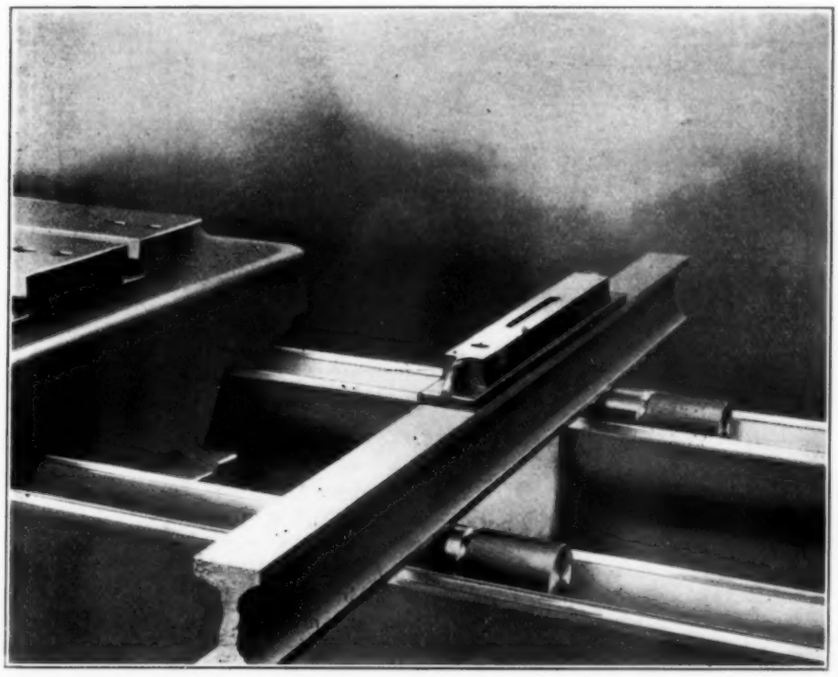

FIG. 7. TESTING PLANER WAYS

On this small planer the swivel tables of the grinders, and smaller jobs, are trued up, and some of the tables which are as much as 10 or 12 feet long by 2 inches thick, after being planed on each side and measured with micrometers, are found not only to be practically without variation in thickness, but when laid on proof staffs and tapped lightly over the entire surface are found to be perfectly solid and show none of that twist that usually exists in long, thin planer work.

Fig. 9 is a view of a somewhat larger planer, and here is shown another test bar with a 90-degree bottom and a flat top on which to place the level. This bar is about 3 feet long, and is moved along the guides and stopped at intervals until the entire length has been tested. The above tests, of course, are both made on each planer; the one for ascertaining the amount of error that exists in the guides with relation to each other and the other for showing the condition of each guide as to straightness from end to end.

The larger planers are used for planing

the grinding-machine beds. These beds are first planed on the roughing machines both on top and bottom, and along one side of the bottom of the beds there is a finished pad running the entire length which is used to line the bed up parallel with the travel of the planer when machining the top and guides. This pad is set against stops on the platen of the finishing machine, and as the tool heads of all of the planers have dowel pins to set and hold them at 45 degrees, it is necessary to take off but a few thousandths of an inch in order to true the grinder beds up, even when planing the 90-degree guide.

The guides of the wheel carriage are also planed on these planers, and when the carriage guides meet the guides of the machine upon which they ride the bearing is all that could be desired.

Another important feature in connection with the planing of the grinder beds is the way in which they are clamped when being finished. There are just enough clamps used to hold them in place, and when clamping them down a dial indicator is first placed in the tool head of the planer; the platen is then traversed until the indicator is directly on the surface to be planed and over the clamping point, when the clamp is tightened, but if the indicator shows that the surface under it changes, the bed is lined up with tissue paper until it can be clamped tightly without the indicator needle showing any movement whatever. The foregoing tests are made on these planers once each week, and any error found is at once corrected by adjusting the wedge blocks upon which they rest.

The wedge blocks are also ingenious, as their adjustment is universal, and while being used to raise and lower the machine they also adapt themselves to any uneven surfaces there may be on the bottom of the machine or on the concrete floor upon which they rest. The Landis Tool Company designed and made these wedge blocks quite awhile ago for use in connection with the large machines in their shops.

All cross rails and tool-head gibs on the planers are kept well adjusted and are not allowed to wear crooked or get out of shape in any way. The tools used for this work bear an important part also as they are forged and ground with the proper clearance to give them a keen cutting edge in order to avoid tearing the metal.

Surfaces when planed by these machines require very little scraping because when tried with proof staffs they show up fine bearing spots which are evenly distributed and the only work necessary to finish the job is to smooth the surface with a scraper and spot it.

E. A. SHRIVER.*

*With Landis Tool Company.

## Fixtures for Special Work

BY HERBERT C. BARNES

The old saying that anyone can do a good job with good tools, but it takes a good man to do a good job with poor tools was never wholly true. The fact is that a good man is needed to do a really good job with any tools, while a job done with poor tools is seldom good unless the cost is much greater than it should be.

In the accompanying sketches, Figs. 1 and 2, are shown a malleable-iron bracket held in a combination cup jig. This was to be drilled so that the holes *A* and *B* could be drilled central in the hubs and the holes *C* drilled at the same setting. This drill jig is composed of a cast-iron frame, with bushings for the drills on three sides and feet opposite each of these sides.

On the top of Fig. 1 is shown the cup bushing *D*. Screwing the cup bushing down over the hub locates the hub in the cupped end, making it central with the hole in the bushing so the hole *A* can be drilled. This also firmly holds it against the post *L*. At the right of the post *L* a pin *F* is driven into the frame. The base of the bracket is supported on one end by this pin and a set-screw *G* holds the bracket against it. In this end of the jig are seen three bushings *H* for drilling the holes *C* in the base of the bracket.

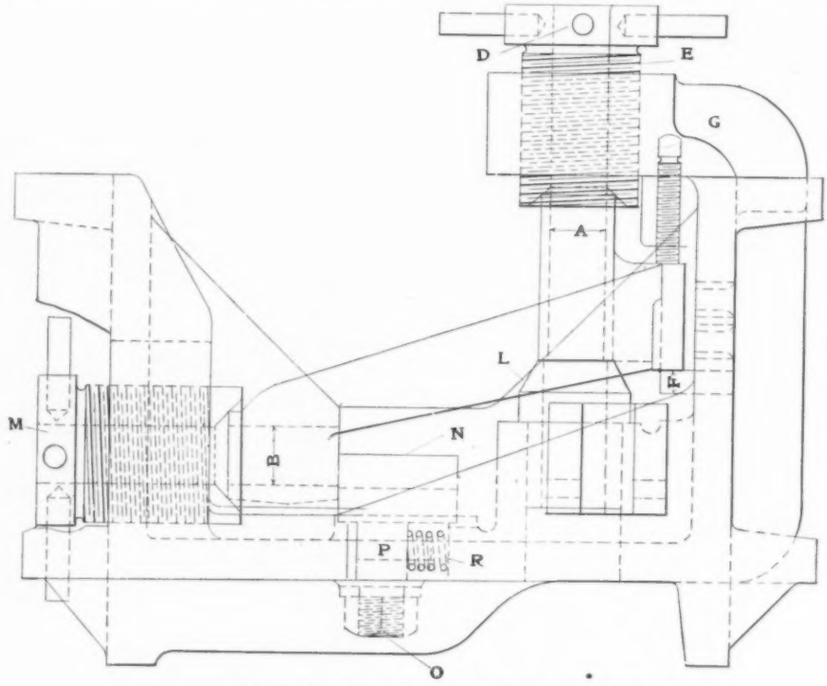


FIG. 1. FIXTURE FOR HOLDING BRACKET WHILE DRILLING

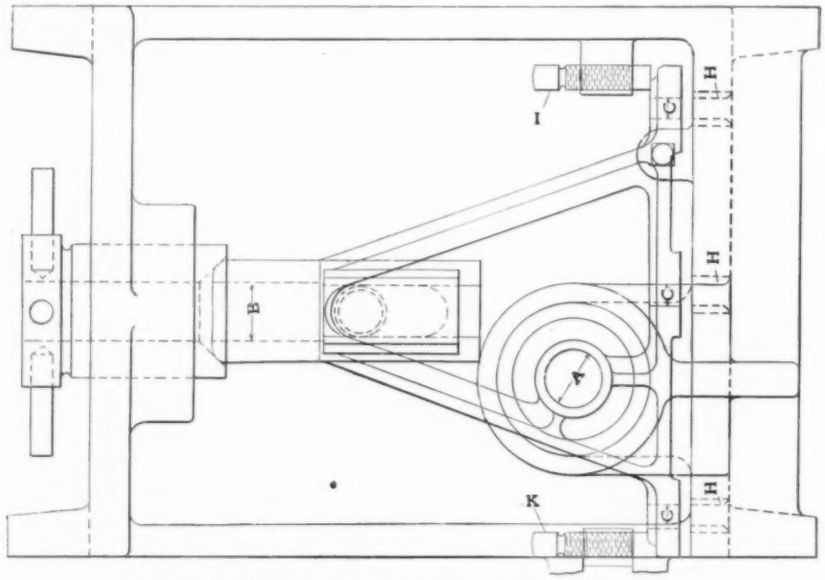


FIG. 2. FIXTURE FOR HOLDING BRACKET WHILE DRILLING

On the inside of the frame the set-screw *I* is screwed through a lug on the casting and the set-screw *K* through a swinging plate which swings down when a bracket is being put in the jig and is raised to hold it in position during drilling. At the left of Fig. 1 is the cup bushing *M* which is turned in the frame to locate the hub with the hole *B* central. The setting of this bushing alines the bracket and determines the position of its base in the jig. In Fig. 1 the moving block *N* is provided with a solid stem on which is a nut *O*.

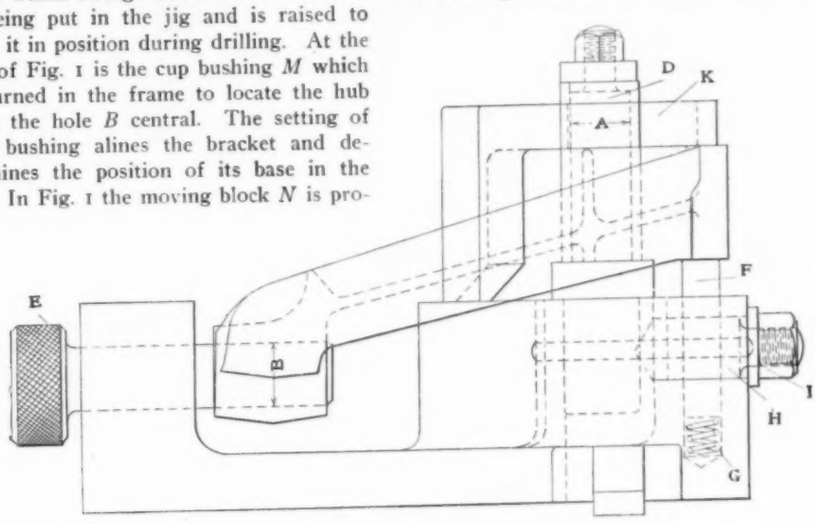


FIG. 3. FIXTURE FOR HOLDING BRACKET WHILE MILLING

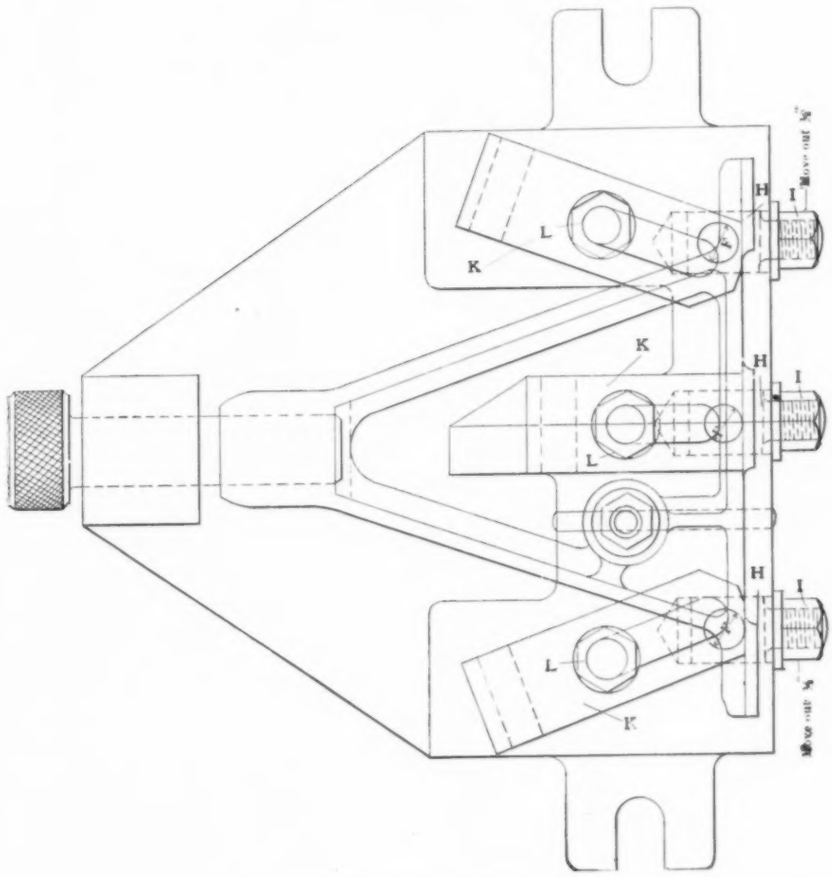


FIG. 4. FIXTURE FOR HOLDING BRACKET WHILE MILLING

The block moves in a finished groove in the casting and is pressed against the boss of the bracket by the spring *R* on the pin *P*, after which the nut *O* is tightened. The block withstands the thrust of the drill when the hole *B* is bored. As this hole is to be reamed, a centering drill is first used in the bushing, after which a reamer-drill bores the hole, then a left-hand spiral reamer reaching through the bushing is used to finish it. Before the holes are drilled the set-screws *G*, *I* and *K* are set against the base of the bracket to steady it for the work. While the bushing *M* may seem to act against the pin *F*, if the castings should vary, the rigid construction prevents their yielding to any such strains.

In Figs. 3 and 4 will be seen the fixture for holding the bracket while its base is milled. In the cast-iron frame are tongues to fit in the slot in the milling-machine table. The hub with the hole *A* is placed over a stud *D* and is held down by a *U*-washer and a nut. The pin *E* is put through a head on the fixture and extended into the hole *B* in the bracket. The jack pins *F* are then released and the springs *G* hold them against the lower edge of the base on the bracket without disturbing its position. The binders *H* are then drawn tight by the nuts *I*, and hold the jack pins firmly in position. The clamps *K* are next set over the top edge of the base, after which they are clamped by the screws *L*. These several adjustments being made, a reasonable amount of care will give the accuracy required.

## Annealing, Hardening and Tempering Tools

By James Steele

In the general treatment of tool steel there is more to be considered than the majority of men who handle it think. In the ordering of steel its general use should be considered. If it is to be put in general use in the machine shop there should be a variety of the different carbon contents. In order to illustrate this we will have to consider a few of the different tools to be made.

An arbor should be made of steel carrying from 60 to 70 per cent. of carbon, whereas if a lathe, planer or any other tool intended for hard material is to be made, then a steel with 1.40 to 1.50 per cent. of carbon should be used. For milling cutters, graving tools, etc., steel with 1.15 to 1.25 per cent. of carbon should be used. For shear blades, chisels, hot sets, large punches, stone drills, coal augers, ball-bearing plates, steel carrying from .85 to 1 per cent. of carbon should be used.

Of the four above grades, but one can be welded by the ordinary method (the forge) and yet we find a great many of the smaller shops with but one grade and trying to make their special tools of every description from this one grade of steel. If the size is not sufficient to make the tool that is desired, it is sent to the blacksmith to be upset or forged to a size sufficient to make the tool.

The forging of steel is one of the very important operations on the steel, and where a steam hammer is not to be had the temptation is very great to get it too hot and, should it be gotten too hot, the smith will shut off his fire and let it cool down for fear of having the steel fly like that much chaff at the first stroke of the hammer. And again in forging a tool that is heavy in some parts and light in others, the smaller part will get hot first and in many cases is overheated, and again the smith will raise the thin part to the top of the fire to cool. This is en-

tirely wrong, the least bit over heat will spoil a piece of steel carrying from 1.40 to 1.50 per cent. of carbon and just a little more will spoil any of it.

The thing to do when a piece of steel gets hot enough to forge is to commence to forge it at once. Do not walk slow and let the heat cool, but get busy and strike while the steel is hot and continue to forge until the heat is moderately low. Even when some thin part of the piece gets to a forging heat it should be taken from the fire and forged but this should not be allowed to happen.

The piece or tool is generally of great value and it should be heated so slowly that all parts would come to a forging heat at the same time and then it should be forged just as rapidly as possible. Whereas to rush a piece through by forcing the heat and getting the steel too hot, which seems to be the general tendency, it will be almost worthless when it is finished.

The next important operation to consider is the annealing of the piece. It is the writer's opinion that more steel is spoiled in the annealing and forging in one day throughout the country than all the poor tool steel turned out by the reputable steel manufacturers in five years time. This may sound strange to some but all that will be necessary will be to make a dozen visits to that many different shops and see them anneal and forge their steel.

After the last blow is struck on a piece or tool it is ready to heat for annealing and not until then. It is not necessary to let the piece cool before heating to anneal, but it is necessary to heat it after it is forged and if the forging heat has not been too high it will not be necessary to heat it more than 1300 degrees Fahrenheit for annealing.

There are many things that enter into the method to be used in annealing. If the piece is a large drop hammer die it should be heated very slowly and evenly and placed in charcoal or air-slacked lime to cool. If lime is used, do not cover the die more than 2 inches as what is termed 12-hour annealing is sufficient, whereas to cover the die deeper, it will require more time for it to cool and dies of this size are not usually hardened more than ¼ of an inch from the outside. If they are too soft, it causes the impression to sink.

If a bar is in the rough, heat slowly and evenly all over the piece and be sure to get the same heat on all parts. To have two or three different heats means just that many divisions of the grains in the steel and this would make a difficult piece for the tool maker to get to size as well as making it impossible for the hardener to get a uniform degree of hardness throughout the piece.

If the work has been roughed out nearly to size then pack in charcoal in a cast-iron box, place in the furnace and heat from 3 to 4 hours. As to the length of time it should remain in the furnace much depends on the size of the piece and the heat in the furnace, when the work is put in place. At no time ought the furnace to be hotter than it is desired to have the work.

Where the operator is not accustomed to pack annealing, bore a hole in the center of the box on the side or end that will be next to the door, and by drawing this bar out, the heat can be determined on the steel to be annealed.

It has long been the writer's opinion that all tool steel should be ordered annealed and all tools made of the original bar if possible, as this lessens the dangers of the over-heats and uneven heats. If the piece is not heated even the grain of the steel will not be even, and will never be alike throughout until the entire piece has been heated as high in all parts as the part receiving the highest heat in the annealing, and if that heat has been too high, the entire piece had just as well go to the scrap heap.

A tool hardener may be ever so good at his calling and return the tools all in one piece, but he cannot restore the steel. Here I wish to state that an article in the AMERICAN MACHINIST, something over a year ago, gave two methods of restoring over-heated steel which are worthy of a place here. No. 1, heat the over-heated piece to a hardening heat and cool in water. Repeat this three times and the tool is ready to be hardened for use. No. 2, heat to 1292 degrees Fahrenheit (dull cherry red), and let cool to 752 degrees Fahrenheit (red visible in dark), then finish cooling in oil. Repeat this three times and the piece is ready to be hardened. The contraction in either method prevents their use on most any tool from the toolmaker, as he is required to do very close work in a limited time, and in turn he expects the tool hardener to return his work nearly the same size that it was when he gave it to him, thus saving many days of grinding and lapping.

As to the heating of steel for hardening there is much to be considered, and no specific degree of heat can be given. To do so it would be necessary to consider the steel, its finish, the general outline of the piece, what it is to be used for, the amount of grinding or lapping, if any, the method of heating, and the method of cooling. Then if a pyrometer is to be used, one could give the degrees of heat necessary.

When a tool is heated and suddenly cooled, it becomes extremely hard, and owing to the internal strain due to such treatment, it is necessarily more or less brittle. The object of tempering is to relieve this strain and remove the brittleness, and the higher the temperature in the drawing the more the strain and brittleness is relieved. The range of temperature in this process is from 420 degrees Fahrenheit, or a faint yellow, to 600 degrees Fahrenheit, or a deep blue. At 750 degrees Fahrenheit steel becomes red visible in the dark.

I much prefer the oil-tempering bath for tempering tools, as tempering to color requires the greatest care, and in fact it would require an expert, as the tempers range from 5 to 10 degrees apart.

## Lubricants Used When Machining Various Materials

By S. J. KELLEY

Cast iron is usually worked dry as in olden times, but I have found that when hard cast-iron gears are to be cut, say, with three cutters, the first cut through will work better with strong soda water. Of course, it makes an objectionable mess, but the work will be done faster and the cutters keep sharper longer than with the dry process of cutting.

Brass and babbitt are usually cut dry, but to hand-ream brass and babbitt is sometimes a difficult task if the reamer is a little dull. Coal oil and turpentine are used with good results and one man can do the work of two with ease. Cast iron can be hand reamed easily with tallow and graphite, mixed, and the whole will be kept just the size of the reamer. Copper can be worked well with lard oil and turpentine mixed.

In boring babbitt bushings and rod boxes in a lathe or boring mill, it is very difficult to work the material dry as the chips have a great tendency to roll around the tool and into a hard ball, thus tearing the metal and making a rough ragged hole. In this case coal oil and lard oil mixed will work well.

Cheap oil is sometimes used as a lubricant for cutting, but soap water or soda water is better for iron and steel shafting and with a sharp tool and light finish cut the work will be smooth enough to polish without filing.

Rawhide is a very peculiar substance to work, and to drill it with a twist drill is a tedious job, as the flutes will clog and stick if run dry. I have seen a lot of drills broken in this manner. A cake of soap held against the drill will prevent all trouble and sticking of drills. It is bad practice to use oil on rawhide as it injures the fiber and loosens the glue. Drills should be run at very high speed in rawhide to work well.

Turpentine is good in some cases where fitting is done, such as scraping lay-out plates, or face plates. Oil will form a coating so that marks cannot be seen plainly, but turpentine will prove beneficial on this kind of work if used freely. The marks can be seen plainly, and the work is a great deal easier to scrape than with an oil surface, as the oil glazes over the surface and makes it hard to start a tool.

# Hardness in Steel and Its Variations

## Crystal and Non-crystal Hardness, Refractory Hardness and Density Hardness, Real and Apparent Hardness Caused by Alloying Material

BY ALBERT F. SHORE*

Since the adoption of the scleroscope as a means for measuring hardness, it has eventually followed that some of the long standing mist surrounding different kinds of steels—especially tool steels—has already been sufficiently cleared away to admit a fairly tolerable explanation as to just what different kinds of hardness mean, how caused, and how they may be detected.

The above instrument, which has already been fairly well described in the columns of this magazine, is so sensitive that to obtain "dead beat" readings, like in other scientific measuring, a constant temperature is desired, as changes of temperature affect the hardness of steel. Thus when hard steel indicates 100 degrees hard by the scleroscope at a temperature of 100 degrees Fahrenheit it will become from 1½ to 2 per cent. harder when cooled down to zero.

After applying an instrument of such close discriminating power to the measurement of various kinds of steel, as well as to those which have been subjected to varying heat treatments, such as over heating, under heating, etc., in combination with other well known methods of testing we must come to the conclusion that in steels there are no less than four kinds of hardnesses: Non-crystal hardness and crystal hardness in carbon steel; the refractory hardness of the alloy steels, and the density due to the hammering of steels and other metals.

*Shore Instrument and Manufacturing Company, 226 West Twenty-fourth street, New York City.

### Non-crystal Hardness

Non-crystal hardness is that property of carbon steel which is much less known than it ought to be, and is what we all seek when we harden a tool by heating it and then suddenly chill it in water.

Pure metallic iron cannot, with ordinary means be rendered fluid enough to cast it, nor does it respond in the slightest degree to such heat-treatment as would harden steel. By adding only a fraction of 1 per cent. of carbon to this pure iron, it can be cast and at once becomes a steel which begins to show signs of hardening by the process of chilling, and if the whole of 1 per cent. of carbon be added it will harden almost to the full limit, depending, of course, on the amount of fiber compression it had received.

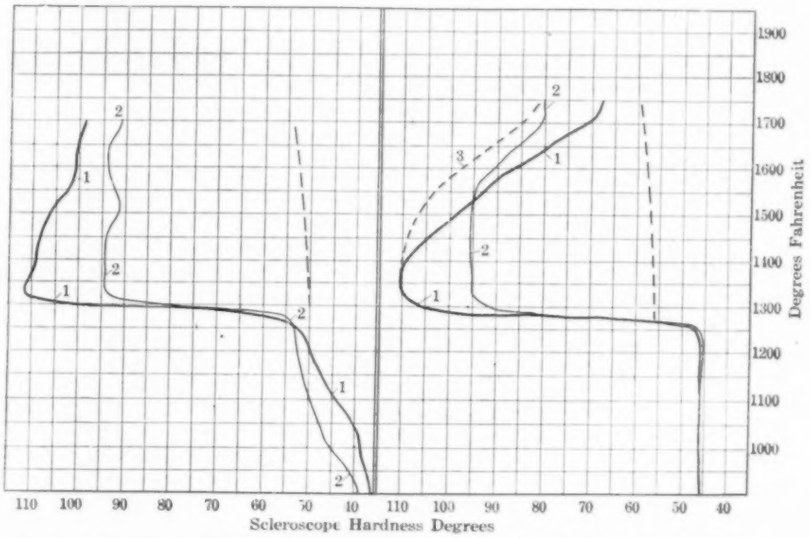


CHART 1. 1.10 PER CENT. CARBON STEEL

CHART 2. 1.65 PER CENT. CARBON STEEL

When thus iron becomes a tool steel because of the carbon it has absorbed, it cannot be said that the two elements have really become chemically combined, although they may be heating to about 1350 degrees Fahrenheit and then quenching in cold water. When thus the carbon and iron have been united, the mass has been converted into iron carbide, or austentite, thus forming a solid and rigid body. Unfortunately the chemical compound produced by this heat treatment is a very unstable one in two ways: By over heating, the mass crystallizes and thus degenerates at the moment the combination is effected, while by reheating the steel thus hardened, to about 500 degrees Fahrenheit much of the soft ferrite is again set free, or in other words the austenite which had been formed is again resolved into cementite and free ferrite.

### Effect of Chemical Change

The effect of this chemical change at the limited temperature cited is to reduce the hardness perhaps 12 or 15 per cent., and the less crystallization there is due to the sparing use of heat in hardening, the harder will be the steel. It will be immensely stronger, and although it is unfortunate, non-crystal hard steel will more readily suffer temper drawing than the same steel slightly overheated for a given amount of color or reheating in temper drawing.

What is peculiar about this hardness at a comparatively high figure in carbon steel, is the ease with which it is possible to scratch its surface with other steels whose hardness measures less in figures, as for example a piece of the same bar overheated enough to have become crystal hard, or brittle hard, and some of the alloy high-speed steels.

This phenomenon is accounted for by the fact of chemical reaction in hard steel when by the application of any amount of heat greater than the boiling point of water, a certain amount of the pure iron, which had been chemically combined with the carbon by the quenching process, is again resolved into ferrite or uncombined iron and is present in microscopic crystals uniformly distributed through the still hard and rigid mass.

### Soft Steel Cutting Hard Steel

When a sharp point of some other steel, which is less hard initially, and which is free from the presence of any trace of free iron, such as a file, is scraped over the surface of hardened carbon steel with the temper thus let down, if it be only 15 per cent., the softer steel having no free iron present will bite on or scratch it, although as the physical strength is now enormously great, no other steel can be found which will actually cut a chip off, because to do this the tool must have a hardness and strength twice as great as the metal cut. It will thus be seen that the only reason why a softer crystal hard steel can scratch a harder tempered steel, is because of the presence of micro-constituted ferrite in formation similar to honey in its cells of wax.

Carbon steel possessing non-crystal hardness is probably the hardest metal alloy known, and contrary to general belief it is harder than the best high-speed

steel, or any other alloy steel on the market.

### Crystal Hardness

Crystal hardness, especially in carbon steel, is usually caused by overheating to the point where the grain previously made dense by hammering or rolling, is again opened, thus enlarging the artificially fine crystals.

The scleroscope shows that the finer the steel used, the greater will be the losses of hardness strength through crystallization, until as a matter of fact, it has dropped from the very high value of 110 degrees to only 70 or 65 degrees on the scleroscope scale, and yet this enormous loss cannot in the least be detected by the hardest file. This phenomenon, taking into careful consideration the figures given, is remarkable.

As we have seen in the foregoing, a good file will bite on tool steel drawn from over 100 degrees in hardness down to about 90. If a file will scratch steel 90 hard, why can crystallized steel at only 70 resist the file absolutely?

### Burned Steel

When steel is burned, its crystals practically become separate masses which harden quite as much as that grade of steel can under correct heat-treatment. This would account for the resistance of the steel, as a mass, to a file which, however hard, is no harder than the individual crystals which compose the resisting mass. Viewing this phenomenon from the side that an accurate hardness-testing machine takes it, we have to add that although each little crystal mass is truly hard, there is a partly open fissure between each crystal so that the composite mass must necessarily be very weak and granular.

In comparing crystallized hard steel with non-crystallized steel the latter is the stronger of the two, as a mass, because of its density and fineness of structure.

### What the Scleroscope Shows

When the scleroscope first began to be relied on for inspecting the hardness of tools, difficulty was experienced in getting the heat just right to get the full known hardening power of the steel into the tools. This difficulty was due to a popular impression that steel should be quenched as soon as the desired heat had been reached. The scleroscope showed that if a steel had only a hardening power of 95 after heating carefully to about 1400 and then quenching, it may be made 100 hard by first heating to about 1450 degrees Fahrenheit then allowing it to cool off to 1350 degrees Fahrenheit before quenching. Not alone was this shown to be the case, but also that while this cooling goes on either in a flame without a blast, or in the air, the edges and other thinner parts which naturally chill the most rapidly, cool off a little more than the heavier parts, so that the internal strains are diminished in quenching thus lessening the warping and cracking.

### Crystal Hard Versus Non-crystal Hard Steel

In comparing crystal hard steel with non-crystal hard steel, the difference is so radical that it can scarcely be appreciated to the extent that it deserves without giving an example. Thus if we were to make a hand reamer out of a steel whose hardening power was 105 and the tool did harden to 105, the accompanying strength would be so great that in spite of the great hardness it would not be necessary to draw or let down the temper of the tool save for merely boiling in salt water.

If, however, the same tool were crystallized so that it would lose, say, only 5 degrees in hardness, which is so easily done that only strict attention can avoid it; then the accompanying loss of strength would be so considerable that it would be necessary to let down the hardness 3 to 5 degrees more to recover the said loss of strength.

A reamer only 95 to 97 hard would soon lose its edge in ordinary service and become below size, while one 105 to 110 hard would last from 10 to 20 times longer.

### Hardness of Files

As in the case of reamers there are many other tools which would be many times more efficient in hard service if they were properly hardened. Special stress should be laid on the file, as almost any workman is aware that some files in their sets will outlast from five to eight others. Some of these will be made worthless after a few vigorous strokes, for the simple reason that either the extreme hook-like edges of the teeth will chip off, or the whole tooth will be stripped off, due to crystallization.

The investigations which I have made show that the only reason why some files are several hundred per cent. better than others is because they range in hardness from 105 to 110, as against 90 to 100 degrees of hardness scleroscope scale, for the crystallized or burned files.

### Testing for Crystallization

The test for crystallization in steel most commonly consists of breaking it and seeing if the crystals are unusually large, granular and whitish. While this test is not a very bad one, it is often out of the question.

In testing tools before they are put into service, or in fact any other finished part which must be of standard hardness and strength, the services of a hardness-testing machine is required, whose application will not mar or crush the piece under examination.

When hardness is tested to show crystallization, the piece should first be tested with the file to show whether or not the temper has been drawn by improper quenching. This is shown by the file biting slightly. Should, however, the file refuse to bite and the piece shows a loss of 10 or 15 per cent. in the measured hardening power of the steel, then there is ample proof that there is crystallization, and it would not pay to use the tool in anything but the roughest work where neither smoothness of cut nor accuracy is desired, and providing no very heavy cuts are to be taken. A tool that has been thus impaired had better be put back in the fire to be annealed and then reharden with less heat than before.

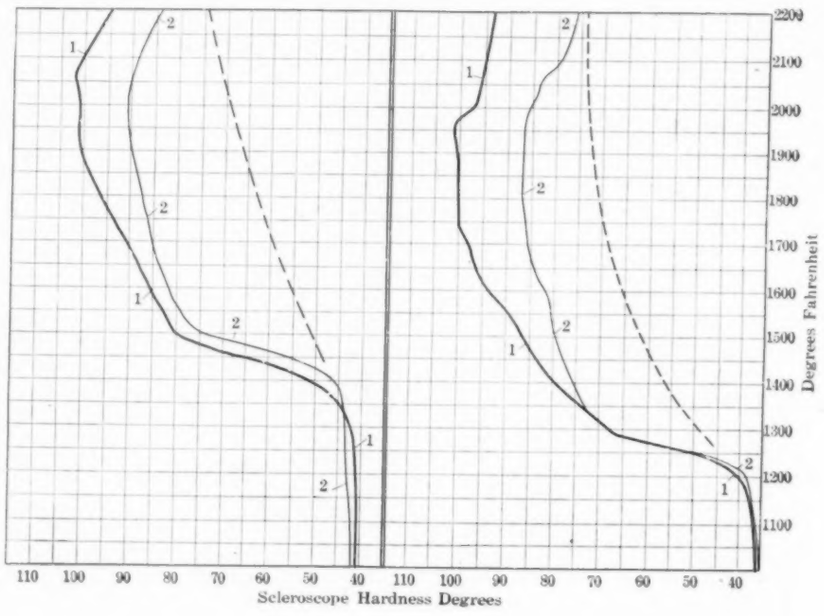


CHART 3. HIGH-SPEED STEEL

CHART 4. HIGH-SPEED STEEL

### Fallacies on Hardening

Experiments and inquiries made by myself have shown that the phenomenon of crystallization in tool and other steels through improper treatment is costing large sums every year. A small factory may lose thousands of dollars annually by the low efficiency of their cutting tools.

These losses are due to two fallacies which are not the exception, but the rule in the shops which have no physical laboratory. The first fallacy is the belief that all you have to do to get the steel harder is to heat it more, and it is common to see fine steel heated to from 1600 to 1800 degrees Fahrenheit. This exorbitant temperature will not only burn the edges off the tool and crystallize the steel, but it warps and cracks them until they are entirely useless.

### Second Fallacy

The second fallacy is the belief that the slightest excess of heat above the degree of temperature at which a steel hardens, will surely ruin the tool. While there is comparatively less danger in this than in the other, and the idea holds good to insure fine results in small work, it becomes almost impractical in larger work for the reason that where a very small tool will harden at the lowest temperature because it chills faster, a larger piece cannot be relied on to harden uniformly.

Steel that has been heated to the point of recalescence between 1400 and 1500 degrees Fahrenheit, and then allowed to cool to 1350 degrees, a very dull red, before quenching will not generate steam and that perfect insulator, hydrogen, when quenched, and will therefore stop boiling almost instantly. This means that the water is taking to the metal, the chill is sudden, and the hardness is not only great, but truly uniform all over.

Curve Chart No. 1 shows the effect of heating a tool steel of about 1 per cent. carbon to near 1800 degrees, while Chart No. 2 shows the effect of the same treatment on steel of 1.65 per cent. carbon. In these, curve 1 represents the initial hardness after quenching at the high heats given on the right-hand side. Curve 2 is for the hardness remaining after letting down by reheating to 520 degrees Fahrenheit, or a purple color. Curve 3 (dotted lines) shows the gain in hardness after overheating the steel as before and then again allowing it to cool down to about 1350 degrees Fahrenheit before quenching.

### Refractory Hardness

The term "refractory hardness" is chosen for such alloy steels as contain one or another of the refractory metals which only melt at extraordinarily high temperatures, and part of which property the steel that contains it inherits, not only chemically, but also physically.

While carbon steel properly treated is still the hardest of steels, it is so unstable on the application of moderate temperatures that steps were taken to make it more immune to at least such heats as a tool would be expected to absorb from the chips while working at speeds greater than would be possible with ordinary carbon steel, and hence the name high-speed steel.

This new property of the alloy tool steels has been investigated by aid of the scleroscope to show to what extent the initial hardness could be preserved after subjecting to a heat of 520 degrees Fahrenheit. The resultant readings are shown in Charts 3 and 4 for high-speed steel hardened at white heat, and semi-high-speed such as carbon steel, when hardened at about the same temperature, in water, as shown in Chart 5.

### Hardness and Strength

In these charts it is clearly shown that contrary to what is generally supposed, the initial hardness of high-speed steel is

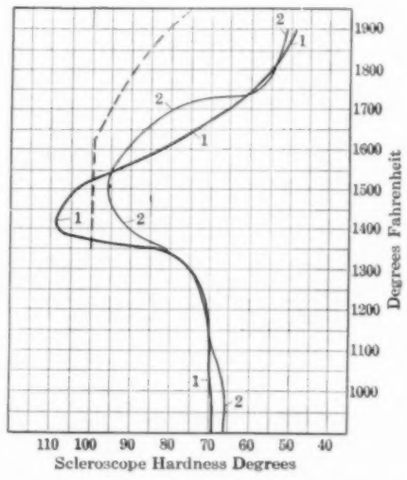


CHART 5. COMBINATION HIGH-SPEED STEEL

not preserved much more than it is in ordinary carbon steel with the same amount of reheating. The alloy steels have other properties besides physical hardness, which makes them resist wear and enables them to keep on cutting after carbon steel has failed.

They are noted for their toughness, although not exceeding carbon steel in strength and elastic limit. It is this toughness which makes steel resist the file, or even the emery wheel, and it resists abrasion more than carbon steel, because after slightly drawing the temper, some of the hard carbide is resolved into uncombined iron whose hardness is about 18 degrees, while that of the carbide is 100 or more.

In high-speed steel it is apparent that tungsten or manganese, etc., will combine more perfectly with ferrite (iron) so that when the proper alloy is hardened in the usual way, and its temper is again drawn, there is no uncombined iron. Consequently a file cannot bite as in order to get started in cutting, one metal must be about twice as hard as another. But this is not all; the alloy steels are tough because they are more ductile or long fibered, especially when soft, and this makes them resist cutting. As an example, copper is harder to cut than brass at the same hardness, or steel compared to cast iron of the same hardness.

### Apparent and Real Hardness

The apparent and real physical hardness is steels perhaps could not better be shown than by specimens of manganese steel in which the latter varies from a minimum to the maximum. Manganese, the element, is naturally very hard and brittle—too brittle to be measured for hardness except by the diamond scratch.

When combined with a little iron to form ferro-manganese, the mass holds together enough to withstand the scleroscope test and it registers 100 hard. When enough of this is mixed with iron to form a manganese steel, too hard to be filed, it can be shown that this hardness to the file test is only apparent, and it may not be 50 per cent. of that of hard steel that may be filed quite as much. Manganese steel acts on the file about the same as a copper and emery lap, in which the emery does the cutting while the copper supports the emery crystals. The combination will cut the hardest steel or glass, although it cannot be said that for that reason the copper and emery as a mass is really hard.

In an alloy of manganese and iron it is apparent that although both are well combined neither change their original identity as to initial hardness. Each atom of manganese remains over 100 degrees hard, while each atom of iron remains at 16 or 18.

### Effect of Manganese

The hardness of the mass in resisting penetration depends entirely upon the number of the harder atoms, and it is for this reason that steel of this kind really soft enough to be hammered or rolled cannot be filed or cut by the hardest tools with success.

As more and more manganese is added to iron it gains in physical hardness until it approaches that of the mineral itself. This, of course, is only cited to illustrate a phenomenon in steel that is very improperly understood in the absence of precision-measuring instruments, and it does not mean that manganese steel cannot be made all that is desired, by a more complex alloy; although it is my opinion that if any alloy steel is really stronger than carbon steel at the same hardness, it must be because of its extreme toughness.

Carbon steel is noted for its very high elastic limit and strength in the outset, while the alloy steels which are also very strong, have a comparatively low elastic limit sometimes as low as 25 per cent.

with the same hardness. Experience has shown that some alloy steels, no matter how hard, when subjected to extreme shocks and strains, will gradually take on a permanent set, while carbon steel will not, although in its effort to hold the original shape it will crystallize and finally fail by breaking.

### Density Hardness

This property is not a natural one in metals nor can it be caused by compression in all metals alike. The most dense metals in their natural state may be hard, and again extremely soft, as for example, iridium perhaps the most dense of all, is a fairly hard metal, while platinum, gold and lead are certainly very soft. Experiments show that density hardness through compression, depends on both the ductility and strength of the metal, and the following are a few examples:

| | Original hardness. | Hardness after compression. |
|---|---|---|
| Copper cast..... | 6 | 20 |
| Brass cast..... | 12 | 26 |
| Iron wrought..... | 18 | 30 |
| Steel annealed.... | 30 | 45 |
| Zinc ..... | 8 | 20 |
| Lead ..... | 2 | 3 |
| Iron gray..... | 40 | 41 |
| Type metal..... | 20 | 21¼ |
| Hard brass..... | 30 | 35 |
| Babbitt metal..... | 5 | 6½ |
| Babbitt metal..... | 9 | 8 |

These figures show that there is much to be learned in regard to the nature of metals which are best suited for bearings and other parts which are subjected to great shocks and compression.

This is shown by the contrast between extra-hard babbitt metal and copper, the latter gaining over 300 per cent. in hardness by compression while the other loses some of the initial hardness which it has as a casting.

## Factors in Germany's Industrial Activity

By Louis J. Auerbacker

During a recent visit to Germany many incidents showed the great industrial activity there, and led me to look into the subject more closely. As a result of this investigation I reached the conclusion that only a great national disaster can prevent Germany from becoming the world's greatest manufacturing country within a few years.

As usual, German thoroughness is the foundation on which this great industrial structure rests. Realizing the increasing demands of trade competition, they are training the coming generation in a manner that must show results which will be felt in all commercial centers. Notwithstanding the handicap of not having the unlimited natural resources which we have, the Germans more than counterbalanced this shortcoming in many ways.

Labor, while not yet quite up to the efficiency of the American workmen in point of speed is, nevertheless, within close range, and at the same time costs 50 to 75 per cent. less. The best mechanics in machine shops get (5 marks) $1.20 per day of 9 to 10 hours; other labor costs are in proportion. Apprentices receive 12½ cents per day, and in a great many cases serve 3 to 4 years learning the trade without compensation. They are taught thoroughly and in addition have the advantage of good trade and other schools.

Manufacturers here know how difficult the "boy problem" is. We pay $4 to $6 per week for a boy and seem surprised if he really does his work in a fair manner. In a few months he wants a raise, and usually gets it if he is bright; if not, he quits the job and gets another. Perhaps it is in the same line, perhaps at some other trade. In Germany the boy, as a general rule, sticks to his job and is assisted in thoroughly mastering his trade. The brightest boys are very often sent to foreign countries at the firm's expense to learn what others are doing, and at the same time to learn languages and methods. Later these boys help to make up the sales force after thoroughly mastering the trade. While the labor unions or social democrats have made large demands, nevertheless they have not greatly interfered with the progress of the manufacturer. The short-sighted policy of our unions in limiting apprentices and other restricting practices have not yet been introduced.

The German manufacturer does not "know it all." Some of his workmen and office force are constantly in foreign countries; our trade journals are closely scanned for new processes or tools. His shops are full of automatic machinery of American make, and he builds many automatics of his own. In factory equipment he is as up-to-date as his American brother. Electric-motor drive, self-stoking boilers, and all other devices of economy are introduced. In the lighting of his factory he uses the latest high-efficiency lamps, such as tungsten and the flaming arc, which are just being introduced to the American market.

His facilities for doing business are assisted by good railroad service at low rates; one price to all. His competitor is not getting any inside rates. The telegraph, mail and telephone service is cheap and very efficient. The parcel post which carries large packages at a fraction of our express rates is also a big assistance. In the large cities, such as Berlin, the local mail service is greatly facilitated by the excellent pneumatic tube system. By putting on seven cents in stamps and marking a letter "Tubular Post" its delivery within one hour is practically assured. The long-distance telephone rate for three minutes' talk is, on the average for long distances, 300 to 700 miles, 24 cents. Telegrams are usually delivered in an hour to any part of the Empire. The average cost for 10 words is about 20 cents.

The employers' liability law is also a good one for the manufacturer. By paying a *pro rata* tax into the national treasury a fund is kept with which all payments to injured workmen are made. If a workman is injured the firm must immediately report to a local inspector who, after investigation, makes the payment to the injured workman at a rate specified for that particular kind of accident. At the same time the cause of the accident is carefully investigated. If it was caused by a process on a machine the facts are published so that all other manufacturers having similar devices can take measures to prevent this particular kind of accident. In a word, the German manufacturer is assisted in every way by his government and is not beset by a lot of grafting local and national officials and laws.

His consular service is up to date. In reality every German consul is a salesman or promoter of trade. One has but to look back a few years to see the strides the German has made in this respect. Where at one time the English had the world's markets, now they have lost most of them, and even must hustle to keep their local trade.

The German packs and makes his goods to suit all conditions. This attention to details is very important and has aided him much. I was in the factory of the largest sewing-machine plant in Germany when a buyer from Sumatra was there. I learned that he still gets machines of an out-of-date pattern on which even the gilding must be identical with past machines received. If the machines varied even slightly from the last the natives would not accept them, as they would think that this change was made to defraud them, whereas it might be a valuable addition to the machine.

It seems strange that we do not look farther ahead. The lack of skilled labor has been keenly felt in the last few years. Instead of assisting in making provisions against this shortcoming we go ahead with temporary expedients; we are not building foundations by the thorough training of our boys in the arts. How long would a mine pay if no ore was blocked out ahead? Could we successfully run our boiler plant with no surplus coal in the bunkers to guard against a case of failure in delivery? In the part our great natural resources have in a measure made up our extravagance, but our high labor cost, which is becoming more inefficient as the pay gets higher and the hours shorter, has wiped out much of this advantage.

The laboring man will also reap what he sows. The millions of dollars in wages which go into making up the merchandise for foreign markets is being paid across the water, where thoroughness, honesty and conscientiousness are working hand in hand for dollars and pride.

# A Variable-volume Air Compressor

## An Unloading Device Which Varies Air Delivered by Quarter-loads and Maintains Full Compound Efficiency at All Times

BY H. V. HAIGHT*

The machine illustrated is a duplex-tandem compound compressor, each side being practically a complete machine. The principal dimensions are as follows: Diameter each, low-pressure cylinders, 25 inches; diameter each, high-pressure cylinders, 16 inches; stroke, 36 inches; speed, revolutions per minute, 85; displacement, cubic feet free air per minute, 3474; rope wheel, diameter, 16 feet; diameter of ropes, 1 inch; number of rope grooves, 18; weight of wheel, 26,000 pounds; weight of base-plate, 25,000 pounds; total weight of machine, 110,000 pounds; horsepower of driving motor, 600.

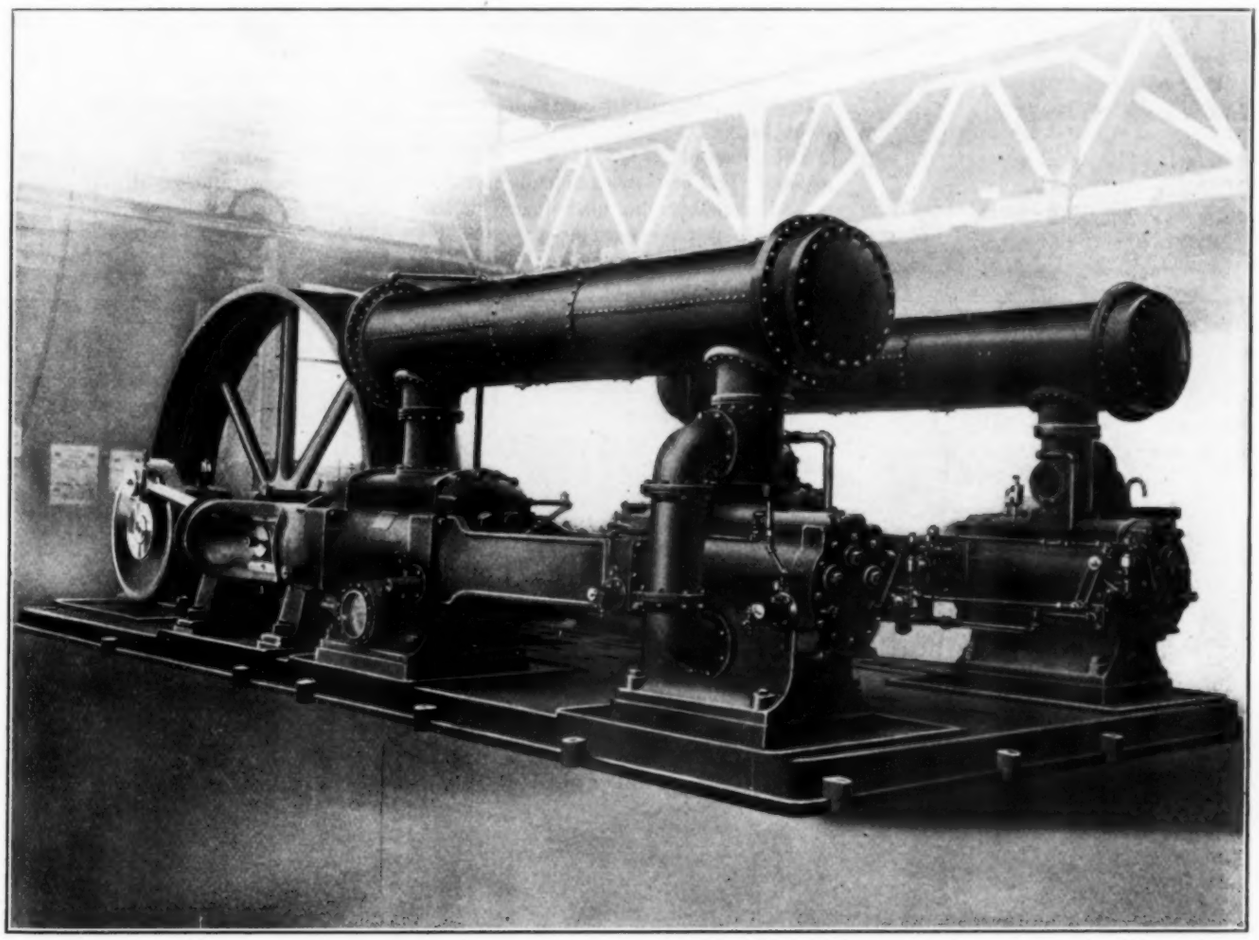

FIG. 1. LARGE CANADIAN VARIABLE VOLUME AIR COMPRESSOR

This compressor was built for British Columbia, where most of the large motor-driven compressors in Canada are located. Practically all of the large motor-driven compressors in British Columbia are driven by ropes, on the Dodge-American system, with long centers, usually 55 feet. The diameter of the ropes is usually 1¼ or 1½ inches. Fig. 1 is not the one belonging to the compressor, as its own wheel had already been shipped. It has a double set of arms, and there is an arm close to the joint on each side to support the heavy lugs. The net area of the bolts in the rim joint is about 23 per cent. of the net area of the rim. At the rated speed of 85 revolutions per minute the velocity of the rim is 4250 feet per minute and the calculated stress is 490 pounds per square inch in cast iron and 2100 pounds per square inch in the steel bolts. It is hardly possible for a machine driven by an alternating-current motor to run much over its rated speed, but even at 41 per cent. higher speed, which would double the stresses, the wheel would still be absolutely safe.

### Varying Amount of Air Compressed

Attention is called particularly to the method of unloading the air cylinders, so that the amount of air compressed will be varied to suit the requirements.

The inlet valves on both high-pressure and low-pressure cylinders are of the Corliss type with releasing gear but without dash pots, as shown in Fig. 2. When the piston is compressing air the valve does not release, but is opened by the eccentric a little after the beginning of the suction stroke (about 3 per cent. to allow for the expansion of the air in the clearance space), and closed by the eccentric at the end of the stroke. The action of the unloader is to admit air to the trip cylinder, shown in section, which pushes out the plunger, pushes down the trip cam, and releases the hook. The valve then remains open and the air blows freely in and out of the cylinder. The valve is pre-

*Chief engineer, Canadian Rand Company, Ltd.

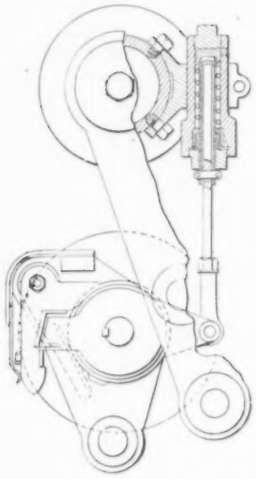

FIG. 2
RELEASING GEAR

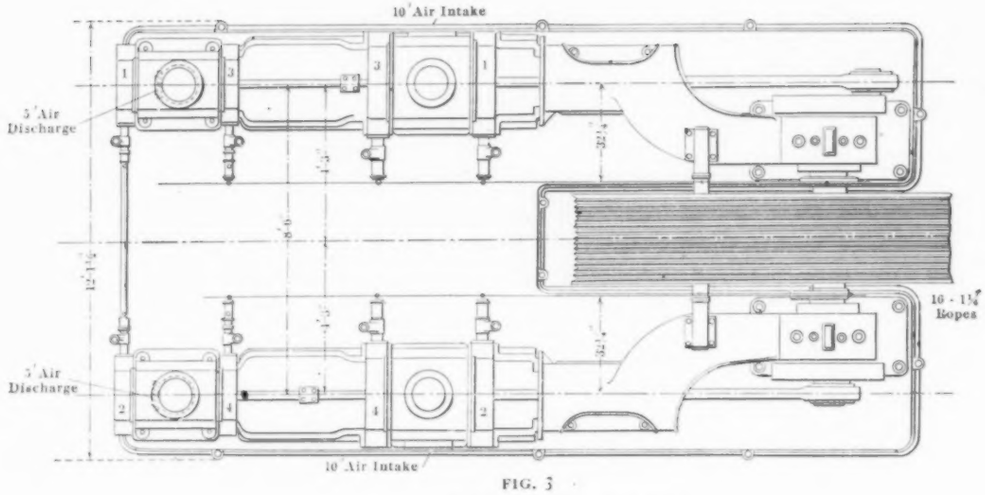


FIG. 3
PLAN SHOWING CUT-OUTS

vented from moving too far when released by the stop on the outer valve bonnet shown in Fig. 4. There are eight Corliss valves, and these are unloaded in pairs in the following order:

1st stage. Left-hand low-pressure front valve and left-hand high-pressure rear valve.

2d stage. Right-hand low-pressure front valve and right-hand high pressure rear valve.

3d stage. Left-hand low-pressure rear valve and left-hand high-pressure front valve.

4th stage. Right-hand low-pressure rear valve and right-hand high-pressure front valve.

The diagram, Fig. 3, will make it plainer. The first stage unloads 1, 1, the second stage 2, 2, the third stage 3, 3, and the fourth stage 4, 4. This gives the following variations of capacity: Full load, ¾ load, ½ load, ¼ load, no load. At whichever stage the machine is working the cylinder ratio is the same, and whatever air is being delivered is being compressed at full compound efficiency.

There are small weights inside the large weights arranged to be picked up or dropped one at a time, at each stage, so that not more than a quarter of the load will be thrown off or on at one time. Throwing on one-quarter of the load at

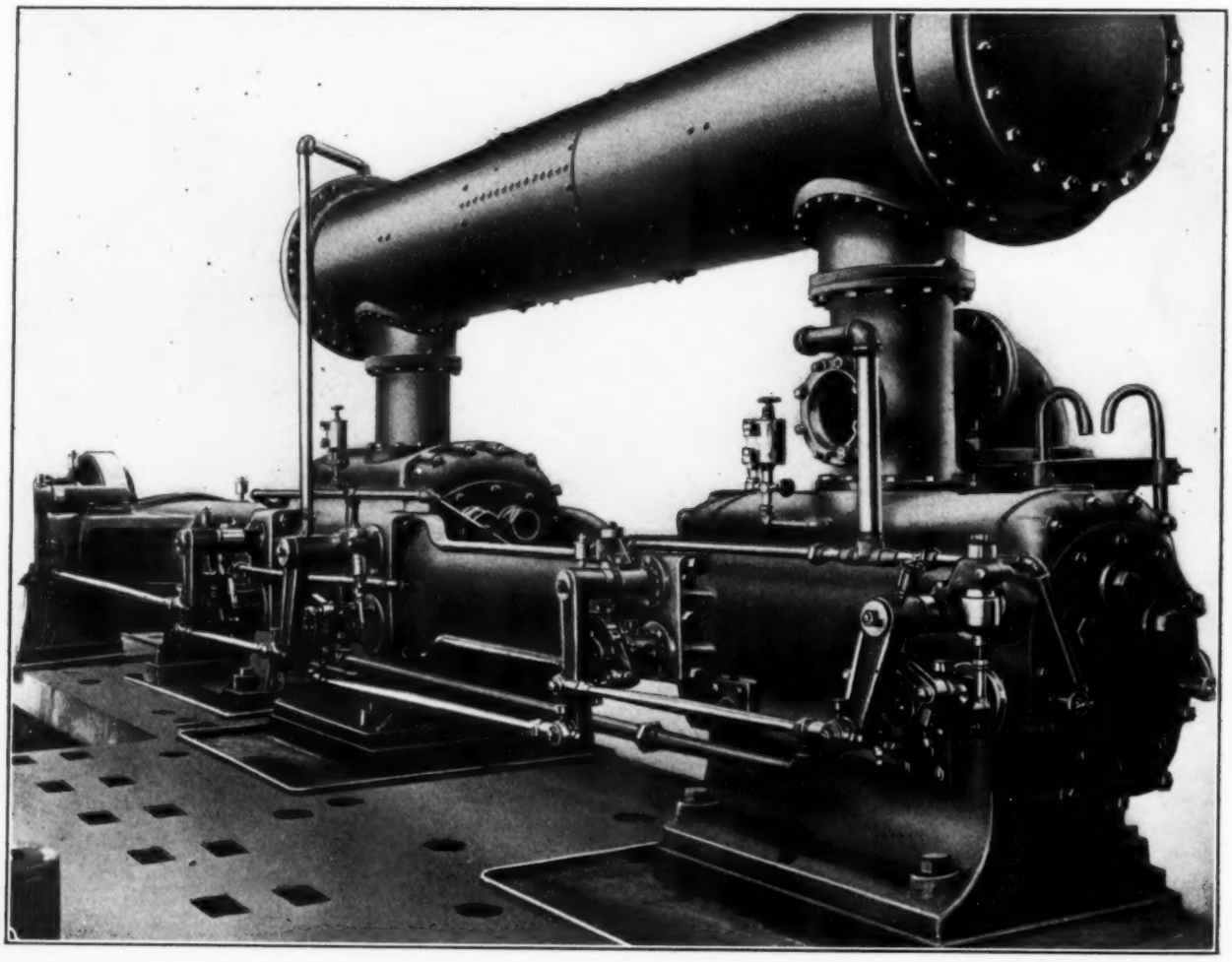

FIG. 4. THE VALVE GEARS AT CLOSE RANGE

a time does not produce any perceptible rush of current in an A. C. motor, while a large compressor in which the whole load is thrown on and off suddenly is apt to produce surges in the line. An advantage of this method of unloading is that at the same time that it reduces the power it also reduces the pressure on the journals; when the capacity is reduced to one-half, the load on the bearings is also reduced to one-half, and when there is no load on the cylinders there is no working load on the bearings. Where the unloading is done by choking the intake, or closing the inlet valves so that the machine draws a vacuum, the full pressure comes on the bearings at the end of the stroke, no matter how much the capacity is reduced. A still further advantage, and one which affects the efficiency of the machine, is that the air is cooler than in the case of any kind of vacuum control.

out freely. The calculated temperature of compression is

$$T_2 = T_1 \left(\frac{p_2}{p_1}\right) 0.29,$$

where $T_1$ and $T_2$ are the initial and final absolute temperatures and $p_1$ and $p_2$ are the initial and final absolute pressures. The final absolute temperature varies directly as the *ratio* of initial and final pressures. When drawing a vacuum the initial pressure is very low, while the final pressure remains the same as in regular working, hence the compression ratio is high and the temperature is high. On the other hand, when the inlet valves are held open, as in the four-stage unloader, the air blows in and out of the cylinder freely, the ratio of compression and the rise of temperature are practically zero, and the cylinders get a chance to be cooled by the water jackets.

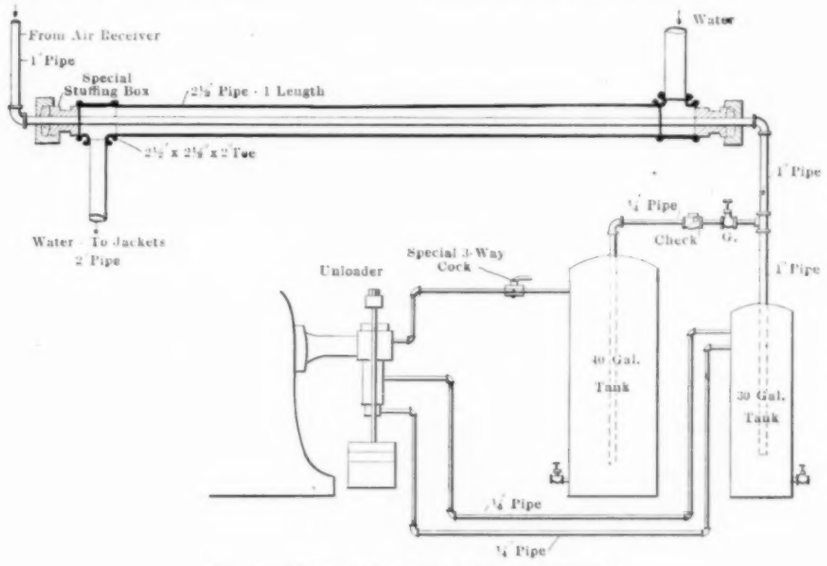


FIG. 5. FOUR-STAGE UNLOADER AIR SUPPLY

### The Result of Tests

An opportunity to test this occurred in the case of two machines, the exact duplicates, and running under the same conditions, except that one had a choking unloader in the inlet pipe, and the other had the four-stage unloader described above. Readings taken on the same day showed a discharge temperature of 221 degrees Fahrenheit for the machine with the four-stage unloader, and 240 degrees Fahrenheit or more for the one with choking unloader. The mercury went to the top of the thermometer; how much higher it would have gone is not known. Another machine of the same size with choking unloader and running under the same conditions showed on the same day a discharge temperature of 278 degrees Fahrenheit. The latter machine was, however, of a different make, and had a very small intercooler.

It is easy to see several reasons why the air should be hotter with the choking control than where the inlet valves are held open and the air allowed to blow in and

The absolute temperature of the discharge is a rough measure of the work of compression. In the instance given above where the discharge temperatures were 221, 240 and 278 degrees, the work of compression would vary as

221 + 460 = 681 degrees = 100 per cent.
240 + 460 = 700 degrees = 103 per cent.
278 + 460 = 738 degrees = 108 per cent.

showing an apparent saving of about 3 per cent. in favor of the four-stage unloader.

### Other Advantages

Another advantage which the four-stage unloading device on the above machine has over a cross-compound machine with choking unloader in the intake pipe, is that the maximum demand for current for the motor may be less than the full load. With choking control in the intake the load is all off or all on, so that in order to deliver even 25 per cent. of its capacity it must run part of the time at full speed, while the machine with four-stage unloader could run all the time at 25 per cent. capacity.

A summary of the above mentioned good points of the duplex-tandem compressor with four-stage unloader is as follows:

1. High efficiency of compression due to maintaining constant intercooler pressure and proper cylinder ratio.
2. Load is thrown on and off gradually, producing no disturbance in electric lines.
3. Reduces load on journals at part loads.
4. Delivers cooler air than any kind of vacuum control, thus also saving power.
5. Maximum demand for current varies approximately with the requirements for air.

### Air Supply to Unloader

In order that the unloader may remain sensitive it is desirable that the air supplied to it should be clean, cool and dry. Fig. 5 shows an arrangement for this purpose and also a starting device. The air supply is taken from the main receiver (not shown) and passes through a length of water-jacketed pipe to cool it and condense the moisture. The moisture and any scale will collect in the 30-gallon tank shown. From the 30-gallon tank two pipes lead to the unloader, one to the bottom and one to the middle. The pipe to the bottom of the unloader raises the weights, while the pipe to the middle supplies the air which operates the trip cylinders. If these two pipes were combined in one, then the unloader would "hunt" or "dance" on acount of the drop in pressure in the small pipe, caused by air being drawn off to operate the trip cylinders.

### Starting Device

The 40-gallon tank is intended to hold air over noon or night so that the machine may be unloaded before starting. By turning the three-way cock, air is admitted by the upper pipe to the exhaust ports of the unloader and from there to the trip cylinders, and releases all the Corliss valves so that they remain open and the machine starts up without load.

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Two large new turbine steamers running between Marseilles and Alexandria have great steadiness through a long period of roll—20 seconds—obtained by such an adjustment of the weights with regard to the center of buoyancy that the resulting moment arm of stability is comparatively short. This does not mean that they are at all unsafe, even though the great superstructure, added to give a maximum of deck cabins, makes the ships appear topheavy. Experiments in the builders' yards have shown that they could be heeled over to an angle of 70 degrees with absolute safety, and the vessels have proved exceptionally stable. One great drawback is a reduction in speed when encountering head winds.

# A Large Flanging Press for Boiler Sheets

## Various Complicated Shapes Are Forged by the Atlas Engine Works with a Press on Which There Are Only Two Side Supports

BY WM. J. WITHEM*

This large press is hydraulically operated at a pressure of 350 pounds per square inch. It has one main cylinder 48 inches in diameter and four auxiliary cylinders each 12 inches in diameter. The table is stationary; the pistons travel downward. In the center of the table is a 6-inch piston which is used to eject the finished flanges from the bottom former.

This machine differs from other types of large flanging presses in that it has only two supports for the head and cylinders, instead of four. This construction gives easy access to the formers and increases the output of the machine by permitting more rapid handling of the work. In it, boiler heads up to and including 72 inches in diameter by 9/16 inch thick are flanged. It is also used for all of the irregularly shaped sheets of locomotive-type boilers. In connection with this latter class of work, it flanges the inside door-and-tube sheets of locomotive boilers where a mud ring is used ordinarily with an ogee that dispenses with the mud ring. All of this work is done at one heat and from one sheet.

FIG. 1. A PIECE AFTER FLANGING. A DRUM-HEAD AND MANIFOLD END FOR A STATIONARY WATER-TUBE BOILER

Turning to the illustrations, Figs. 5 and 6 show the press, and a plate ready for flanging and the same plate after flanging. The finished piece is shown by Fig. 1. It is a drum head and manifold end in one piece for a stationary water-tube boiler. When it leaves the flanging press it is complete with the exception of the manhole which is punched in a succeeding operation. In flanging this particular piece, the sheet is heated to a temperature between 1200 and 1300 degrees Fahrenheit and centered on top of the lower former. The press is then operated and the piece is completely formed by one downward stroke of the pistons. Angle

*Department foreman, Atlas Engine Works.

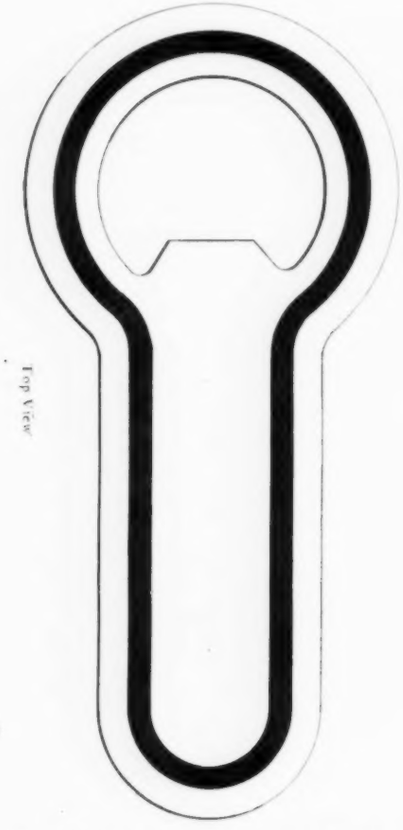
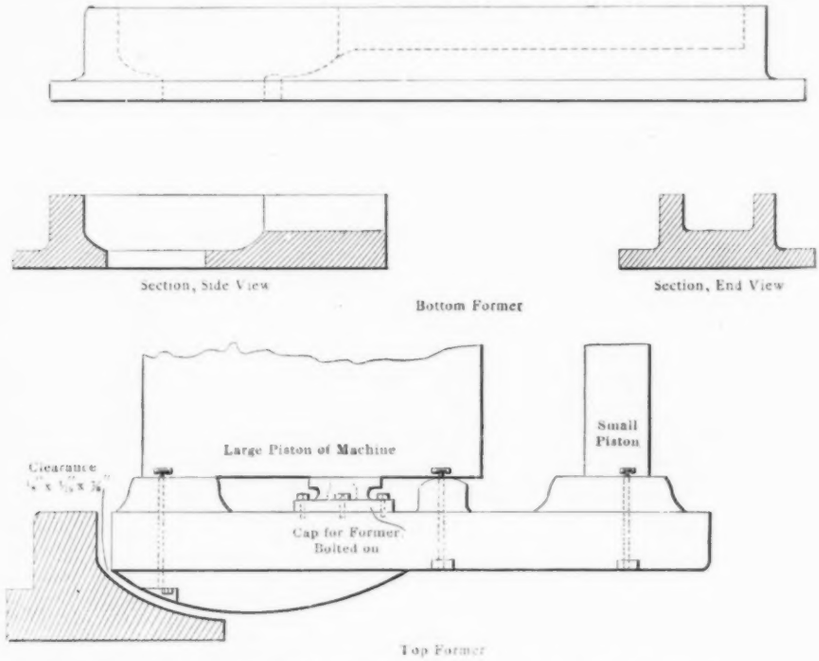



FIG. 2. BOTTOM FORMER FOR PIECE SHOWN IN FIG. 1




FIGS. 3 AND 4. DETAILS OF FORMERS FOR PIECE SHOWN IN FIG. 1

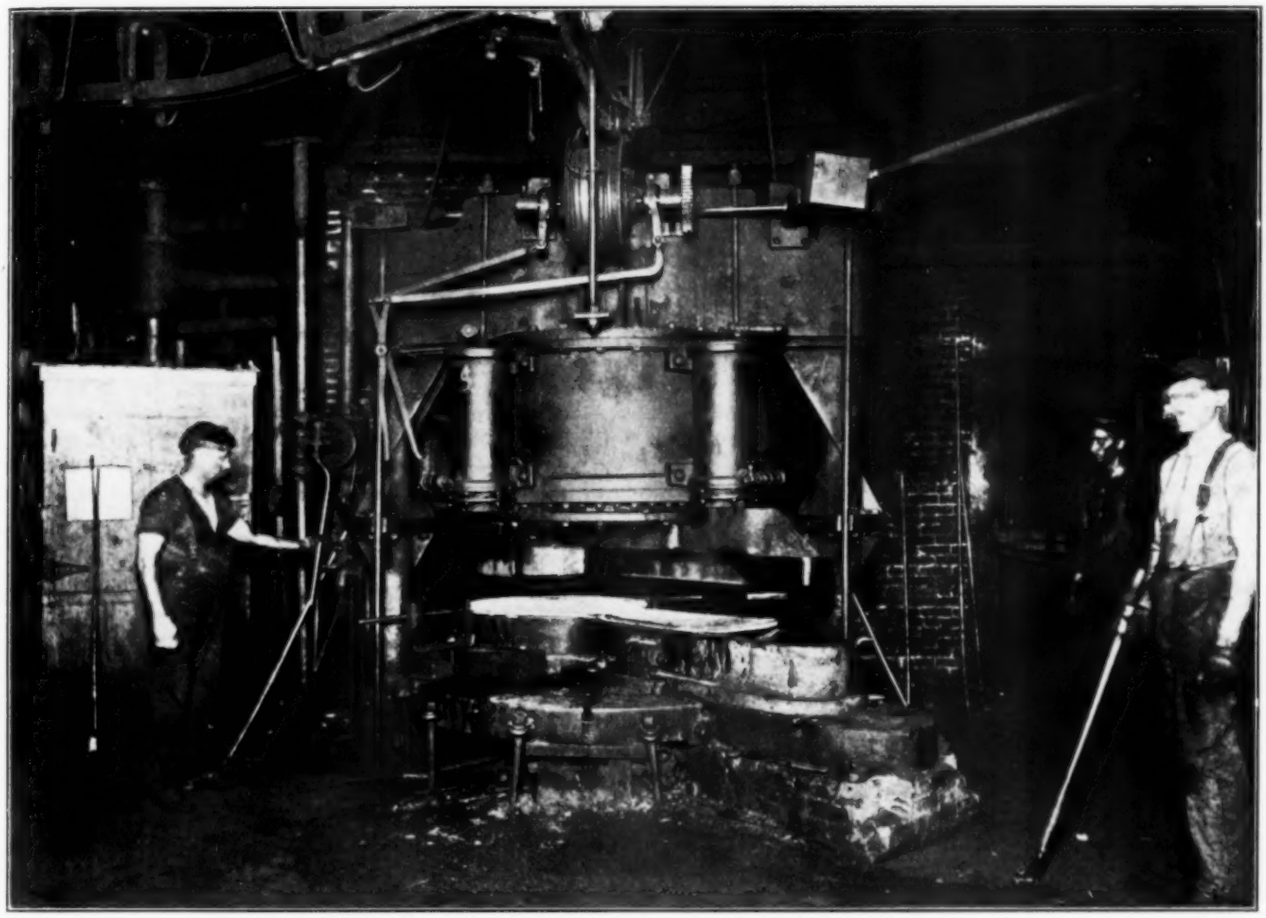


FIG. 5. FLANGING PRESS WITH SHEET READY FOR THE FLANGING OPERATION

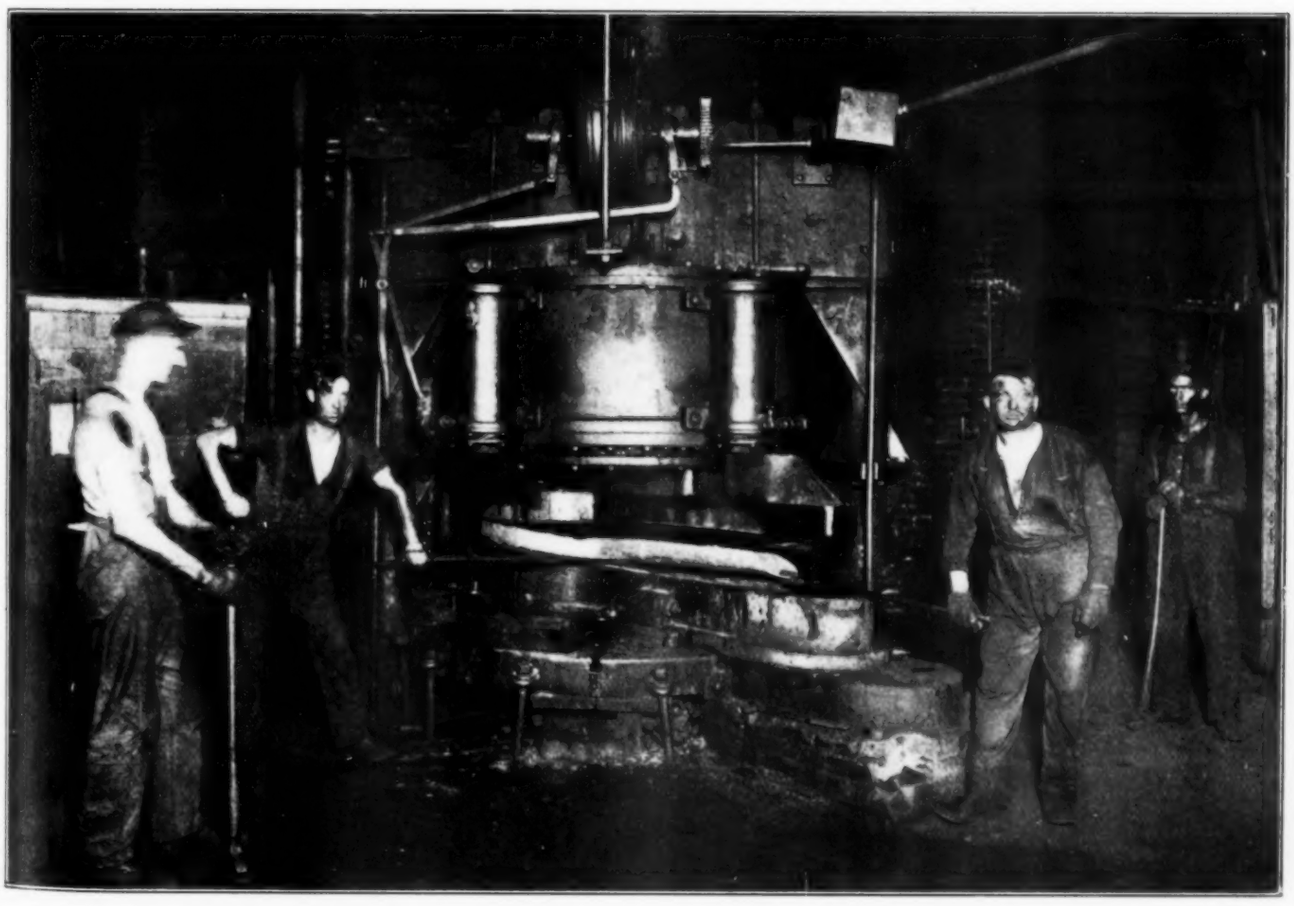


FIG. 6. FLANGING PRESS WITH PIECE FLANGED

clamps are arranged on all sides of the lower former, with pins running through holes in them and set close to the upper former, so that, if, after forming, a piece should cling to the upper former these pins will catch its edge and pull it off. This stripping, of course, takes place on the upward stroke.

On the front of the machine is a drum upon which is wound a flexible wire cable attached to adjustable tongs. These tongs grasp the heated plate, and by winding the cable upon the drum the plate is drawn from the furnace. As the drum is operated by friction clutches it is very easy to stop the heated plate in a correct position on the lower former.

Figs. 2, 3 and 4 show the formers for this job. They are made of cast iron, are very accurately fitted and great care is used in planning for sufficient clearance so that the expansion or upsetting of the edge of the plate will not injure them.

Fig. 7 shows another interesting flanging job. The piece is known as a "throat brace" and is for stationary, water-tube boilers. The plates used are 7/16 of an inch thick.

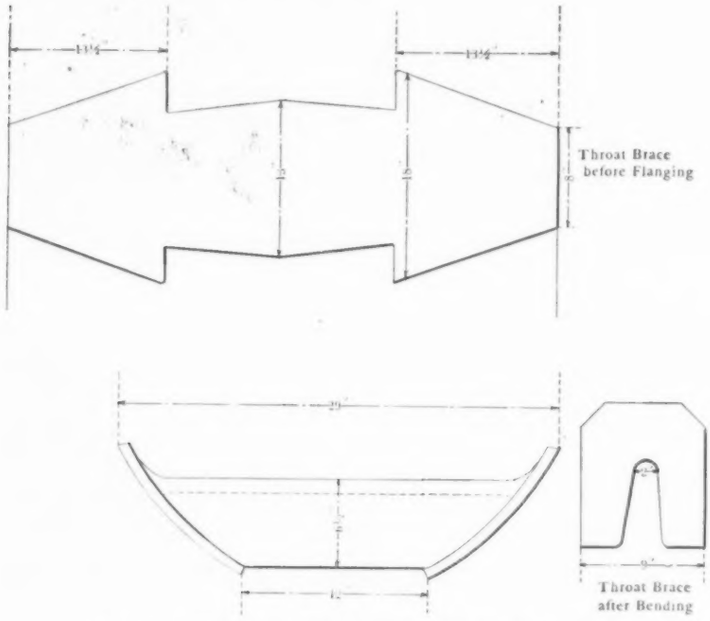



FIG. 7. SHEET FOR FLANGED THROAT BRACE FOR A BOILER

Fig. 8 shows the formers which are used for this piece.

This press has been in use for some time in the plant of the Atlas Engine Works, Indianapolis, Indiana, with success. At no time have more than four men been required on any of the flanging work. The up-keep of the machine has been negligible; almost no repair work has had to be done.

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A new bullet-proof coat is reported to have been invented by a Russian colonel. The coat is said to contain platinum, silver and iridium, is less than 1/50 of an inch thick and will withstand a bullet fired a few feet away.

## Iron and Castings for Piston-ring Blanks

By A. Manchester

Many of the men who are foremen of iron foundries in which castings for steam engines are made, have been up against the packing-blank question, and as I write I have a letter from an old friend asking for a mixture of iron having the necessary qualifications, as cast iron is the most satisfactory of the metals for wear in packing or piston-rings, and experience has demonstrated that piston rings of cast iron will wear smoother, better, and equally as long as those of steel and longer than those of either wrought iron or brass, whether the cylinder in which it works be composed of brass, steel, wrought iron, or cast iron.

In some of the foundries making large cylinders, packing or piston-ring blank castings are poured from the same mixture as the cylinders. These rings do not depend on the spring in the ring to keep them out in place, but are furnished with special springs to do so. On the other hand, there are numbers of packing rings so small in diameter that the ring must have spring enough to make it spring into place when forced on the cylinder, and it is to rings of this style I wish to refer. In some foundries it is the custom to cast packing blanks thick enough for several diameters of rings to be turned from the same casting.

Suppose a blank pattern is furnished which is 1 inch thick and 10 or 11 inches in outside diameter, and rings are wished which will call for removing ¼ inch on both the outside and inside of the blank. What kind of iron will remain in the ring, and what will be its nature? Will the ring be as lively as one which had not as much iron removed from both sides, but more from the outside and less from the inside? If there is a difference, what is the cause of that difference?

In packing blanks made from the general gray-iron mixtures, it will be found under certain conditions in a thick piston-ring blank that the iron will be of a more open nature in the center between the outside and inside walls of the casting, and when these are turned off, the more open and porous part of the casting remains. This is not as springy, as it has lost a part of its vitality and energy in having its closer grained parts turned off.

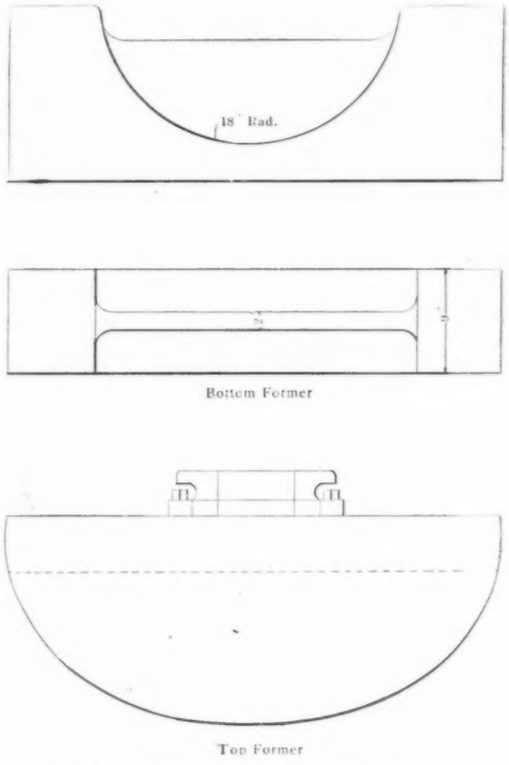



FIG. 8. FORMERS FOR BOILER THROAT BRACE

Make a wedge pattern 18 inches long, 3½ inches wide, 5/16 inch thick at one end and 2½ inches at the other, cast it on the flat, and gate it at the thick end. Pour this, and your piston-ring blank of the same iron. When cool, slightly notch across, break every 1½ inches from the thin end, and note the crystallization as the thickness increases. In doing so you will see that as the thickness increases so the crystals become more noticeable, and when you come to the thickness that represents your packing blank note the crystallization. Ask yourself what the iron will be and its nature when you have turned off the outside and inside finish allowed.

The thin part of the wedge shows a fine close appearance, and where it measures the ½ inch in thickness, you exclaim that is the kind of iron you wish, and you naturally say why does it show a coarser nature as the wedge increases in thickness?

The thin part of the wedge shows a fine grain as it cools more quickly than the rest and as the wedge increases in thickness the grain is more open, owing to its being thicker and taking longer to cool. Thus it is this time taken in cooling which influences the iron and causes these changes to take place in the granular formation, or crystallization of the wedge.

I wish here to quote from "Metallurgy of Cast Iron," by Thomas D. West, page 420, a book which has done more to help the foundrymen than any book which it has been my good fortune to read.

"The carbon held in fluid iron, authorities claim, exists in a combined form. How much of this will change to graphite when the casting, or iron, has solidified and become cold enough to handle, depends first upon the time of cooling, and second, on the per cent. of silicon, sulphur, manganese and phosphorus which exists in the iron. The greater the silicon up to nearly 4 per cent., also the phosphorus up to 1 per cent., and the lower the sulphur and manganese, taking into account also the time consumed in cooling, the higher we will find the graphite carbon. The greater the formation of graphite the more open or large the grain of the iron."

Thus as the wedge increases in thickness it cools more slowly, and in cooling slowly, allows the formation of graphitic carbon in proportion to the time taken to solidify.

To quote again from the same author, page 421:

"The formation of graphite may be compared to the cooling down, or evaporation of a saturated salt solution. If slow we get big crystals; if rapid, we get smaller ones. This is similar to the cooling of liquid iron to a solidified cold state. The longer the period for cooling the greater the expansion of the molecules and grain of the iron which is defined chemically by our having higher graphite in slow, than in fast cooling."

Thus it will be seen the thickness of the casting will determine the time it takes for the casting to solidify, and the granular formation of the iron in the casting is affected by the time it takes to solidify.

The question is then, how are you going to obtain the desired texture in the metal? If you make the pattern 1 inch thick, and turning off the amount quoted, you are calling on your foreman to mix an iron with less silicon, other properties being equal, so that as the iron solidifies less graphitic carbon may be formed, and more combined carbon remain; then when the casting is received at the lathe by the man who has been turning the soft iron, he immediately calls it hard iron, as the scale will be harder, yet when he removes the amount of finish you have insisted on having, you have the iron in the center of the casting as you desired it.

Having irons of a different chemical analysis which makes them different in quality and so different in number, from these different numbers we select certain grades, or numbers having certain chemical proportions, and these will give us castings of the desired properties if while doing it we take into consideration whether the casting be thin or thick, as this determines the time it will take to cool, and is an important factor, and in the thinner castings is a very important one.

In "Mechanical Engineer's Pocket Book," by William Kent, page 336, I quote, showing some conclusions from tests by Professor Turner: "After enough silicon has been added to cause solid castings, and farther addition and consequent increase of graphite weakens the casting. As strength decreases from increase of graphite and decrease of combined carbon, deflection increases; or, in other words, bending is increased by graphite."

Thus my own experience has been that where the outside of the piston-ring casting was turned off to such an extent that the open porous center of the casting was left to form the packing or piston-ring, what is commonly known as set is the result, and as far as I can learn, this is the experience of others. As the casting is robbed of its combined carbon and the graphite remains, the ring loses its elasticity or ability to spring back into position, as it is of a dead nature.

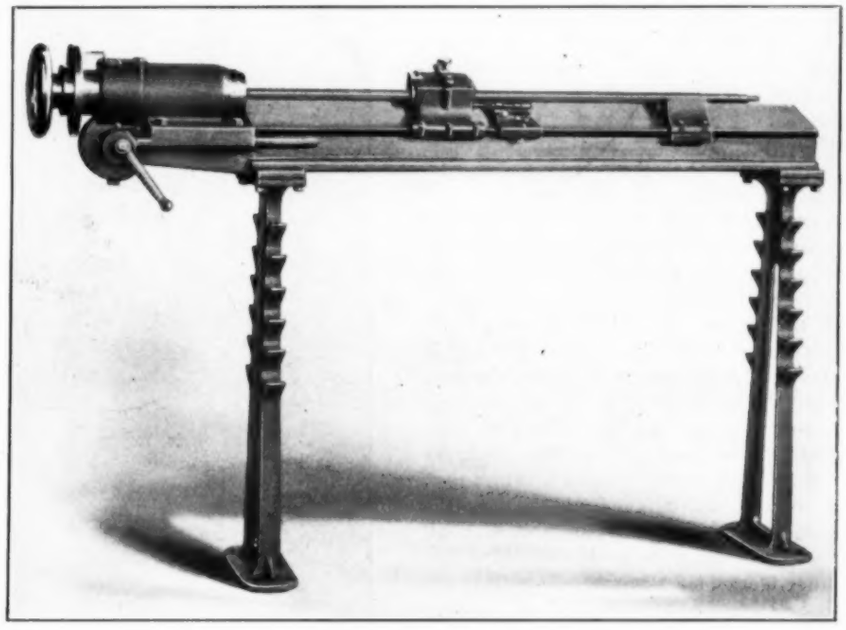
I have found that the best and most satisfactory small-diameter piston rings were turned from blanks as near the finished size of the ring as it is possible to cast them.

The foundry foreman who has a large cupola is often called on for some few castings which do not weigh enough to make a charge, and is compelled to change the iron while in a fluid state for these castings. This he does by adding steel shavings, and the addition of steel shavings to the iron which is to be poured into piston-ring blanks is beneficial to it providing the steel shavings are low in carbon.

In molding small packing blanks where the castings are to be finished in a lathe, and they are cast near size, I have found it better to rattle them and leave the sea-coal facing off. If the blanks are to be ground instead of turned, the facing should be put on.

## Measuring the Lead of Screws

The efforts to produce screws with as perfect a lead as possible have led to many ingenious devices for measuring such errors as exist after a screw has been cut, as well as to means for cutting a more perfect screw.



MACHINE FOR MEASURING THE LEAD OF SCREWS

Now that feed screws of milling and boring machines are being used to lay out work with micrometer graduations to thousandths, it is as necessary to have them accurate as it is the lead screw of a lathe, so that the demand for good (it is useless to say perfect) screws is constantly increasing.

The Cincinnati Milling Machine Company is using the measuring machine shown, which is the same as is used by the Hendey Machine Company, Torrington, Conn., being designed by their superintendent, Mr. Norton. It is a very simple device, which can hardly be said of some of the instruments devised for this purpose,

and has the further practical advantage of allowing standard test blocks to be used so that the readings do not depend in any way on the accuracy of graduations of the machine itself.

The headstock carries a substantial spindle with a draw-in chuck for holding the screw to be tested and is driven by a pair of spiral gears from the handle shown, the only function of the driving mechanism being to turn the screw an exact number of revolutions. This is made easy by the use of the large disk near the draw-in chuck handle, with its pointer as shown.

The other end of the screw simply rests in a tail block to support it while the actual measuring is going on.

The largest block in the center carries the nut which fits the screw and which is fed along as the screw turns, carrying the block with it. There is also a stop on this block which is in line with the screw of the micrometer head mounted in the small slide.

With the screw in place and the nut clamped in the block to prevent turning, the micrometer is set to zero or to any point desired, and the small block moved to give a determined distance between the two points. In practice a 12-inch standard distance piece is used and the points set to this. Then the screw is given the required number of turns to move the block as far as desired; six inches is the practice of the Cincinnati Milling Machine Company, and a 6-inch block is tried between the points. If it just fits, which is practically out of the question, the screw is perfect for this distance, and it also enables the exact variation to be read from the micrometer.

The Hendey Machine Company frequently tests lead screws every inch, by using first a 12-inch standard, then an 11, a 10, etc., but this machine allows the tests to be made in any way you wish, all that is necessary being the standard distance blocks for whatever points that are to be tested.

The legs are made with rack projections on each side so that screws can be laid on the machine for convenience when it comes to testing them.

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Many tests have been carried on to ascertain percentage of swelling that takes place in cast iron and these tests have shown the possibility of producing a swelling of as much as 40 per cent. in the volume of cast iron, by heating and cooling. A bar measuring one inch square by 14.8 inches long was heated and cooled in a gas furnace 27 times, the high temperature being 1450 degrees Fahrenheit. Careful measurements then showed the bar to be 1⅛ inches square, and 16½ inches long. It is thought that this fact explains many of the difficulties experienced with cast-iron fittings for use with superheated steam, where the same sort of alternate heating and cooling takes place.

## A Compressed-air Reaming Bench

The accompanying illustration shows a highly novel and meritorious application of compressed air at the Detroit shop of the Chicago Pneumatic Tool Company. The outfit consists of a half dozen thoroughly made cast-iron vise benches, with an oil channel surrounding each one and an oil pan on the front side. Suspended above each vise and balanced by a counter weight is a rotary air drill properly piped as shown, the use of the entire outfit being in the reaming of the numerous parts requiring it.

COMPRESSED-AIR REAMING BENCHES

Those who are familiar with these works will remember that they are fitted with an oil-supply system served by a pump in the engine room with return pipes to carry the oil back to the pumps after using. The oil pipes connected with the pressure main will be seen in position delivering oil just where needed, while the oil channel surrounding the bench and the pan in front insure the return of the oil to the pump.

It will be seen that the conditions for doing good work with this apparatus are ideal—superior even to hand reaming. The operator does no more than steady the apparatus by the handles provided, while, the power being self-contained, the reamer is absolutely free to follow the work—even more so than under the effort of turning the reamer which is involved in hand reaming as commonly done. Obviously, too, the work is done more rapidly, more easily and more economically than is possible with hand reaming of numerous pieces. After the reamer has gone through a piece of work it is simply lifted out of the way and remains suspended in position for the succeeding piece.

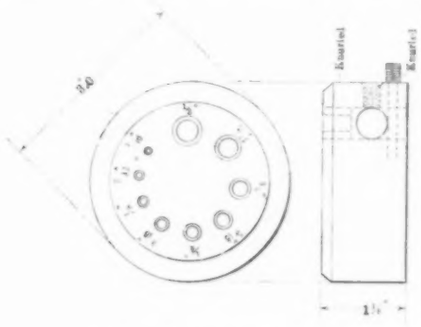
# Practical Letters From Our Readers

## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### Jig for Drilling Balls

The jig shown has worked most satisfactorily, and is an ornament to any tool maker's kit or a tool room. It is simply a round block of cast steel having as many holes as is desired, and hardened and surface ground. The holes are lapped, the hard bushings pressed in, and can be replaced when worn out.




A JIG FOR DRILLING BALLS

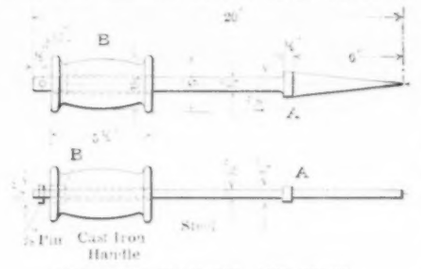
The ball is entered from the bottom, and held in position by a binding screw whose point is cupped. The ball rests on a pin while being drilled.

The jig is made of such a size as is convenient to the hand, and the side is nurled. After the ball is drilled and burred it is ready to reharden.

Waltham, Mass. S. W. GREEN.

### Combined Drill-press Drift and Hammer

The illustration shows the combined drift and hammer in one tool. A collar was forged at *A* and the handle of the drift drawn out to form a rectangular bar that is used as a guide for the cast-iron hammer which serves as a handle. The end of the bar was drilled and a pin driven in to prevent the handle from coming off. The end of the handle at *B* was recessed to allow the end of the drift to come flush with the cast-iron handle, and thus make it possible for the operator to stand it on end in an out-of-way place.




COMBINED HAMMER AND DRIFT

Aurora, Ill. JOHN B. SPERRY.

### A Blanking and Drawing Die—Toolmakers' Face Plates

I do not call to mind ever having seen a blanking and drawing die like the one shown in Fig. 1. This die draws a perfectly smooth shell as shown in Fig. 2, and there is no loss from metal tearing. It was found that with the regular compound die the percentage of loss from tearing was so great it was cheaper to make the shell in two operations, and it was so made for some time until a die like Fig. 1 was used. The punch *A* is made with a flaring mouth a little longer than the length of the shell. The shedder has no springs and is used only as a knock-out. The springs on the stripper of the die *B* are also only used to strip the shell from the former *C*. Millions of pieces have been made with this form of die with no loss from torn shells owing to difference in temper of metal. The shells are made of brass. On page 984, Vol. 30, Part 2, is shown a face-plate with T-slots at 90 degrees to each other. The same idea has been used by toolmakers on bench-lathe face-plates for a long time. There is only one way to drill these face-plates properly, and that is as shown in Fig. 3, although the common and most used method as shown in Fig. 4 is wrong. I have never seen any piece of work that could not, within the limit of the face-plate, be clamped to it if the holes are drilled by the 90-degree method. But I have often had to drill extra holes to secure a piece to the plate when it was drilled radially, as shown in Fig. 4.

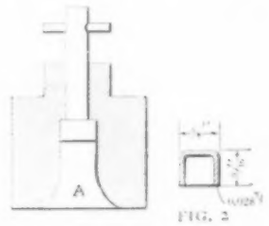



FIG. 2

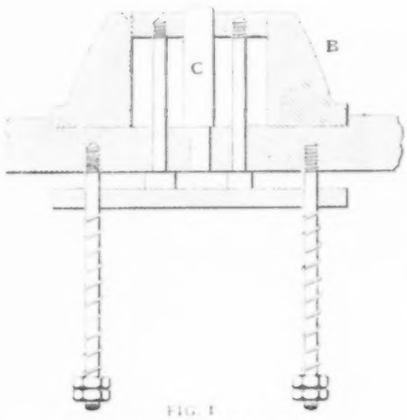



FIG. 1
THE WORK AND THE TOOLS

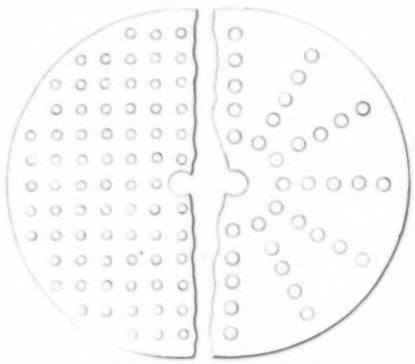
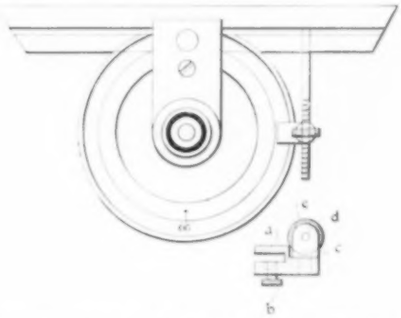


FIG. 3 FIG. 4
TOOLMAKERS' FACE PLATES

Chicago, Ill. THOMAS MCCABE.

### Screw Adjustment for a Protractor

The clip *a* is clamped to the protractor by the flat-pointed screw *d*. The stud *c*, which swivels in *a*, as shown, carries the adjusting screw *d*, adjusted by the nurled nut *e*. The end of the adjusting screw is bent over to fit closely in the slot in the protractor blade.




SCREW ADJUSTMENT FOR THE PROTRACTOR

In certain positions of the protractor it is necessary to clamp the device on the opposite side, the swivel of *c* in *a* providing for this.

Tool- and diemakers will find this worth while.

St. Louis, Mo. A. HANTON.

# An Eccentric Turning Job

Some time ago our company had a contract for several hundred special machines for rolling the wrappers on cheroots. The actual rolling was done by two sets of fingers which were operated by eccentric shafts such as is shown in Fig. 1, and on account of the number of these required, which was over a thousand, we used special methods in their manufacture. Because of the fact that there was no allowance for tools for these pieces in the estimate, and we did not expect to make more than the one lot, the tool cost had to be kept down to a minimum, and some rather ingenious makeshifts were used in getting them out. The first consideration was as to whether they should be turned from solid stock or not. After some discussion it was decided that a set of drop-forge dies would pay for themselves, so when the stock reached the machinery department it was in the shape of drop forgings, with about 3/32-inch finish on the various diameters and 1/16 inch on the shoulders.

We first made multiple toolholders, two with two tools each for turning the eccentric end, and two with four tools each for turning the long end and the collar. The grooves in which the tools were located were at a slight angle with the body of the holder, and were made nearly 1/16 inch wider than the tools so that the latter could be ground for a side cut without being too particular, and easily set for the distances between shoulders, see *A*, Fig. 2. One holder of each kind was used for roughing and one for finishing. The long end was turned first and the pieces were centered on that end only. For holding the other end and at the same time serving as a driver, we made four dogs like Fig. 3. These dogs had a center in one end and a hole in the other eccentric with the center and large enough to receive the second shoulder of the eccentric end in its rough state, the setscrew being used to bind it. The sides of the dog were flatted off parallel with the plane passing through the center lines of the hole and the center, and equidistant from the hole, so that the thickness of the dog was the same as the diameter of the collar on the forgings. To set the piece in the dog, we put it in place in the hole, laid the dog on one of its flat sides on a surface plate, turned the piece around until the collar touched the plate, and tightened the set-screw. The dog was driven by a bolt in the faceplate of the lathe. As we could not set the dogs twice alike on the rough stock, we used one lathe for roughing and another for finishing, and did not remove the pieces from the dogs until they were finished. The operator filled the extra dogs while the lathes were running, to avoid delaying the work.

The same tools were used for both turning and facing the shoulders and in order to get the latter square, it was necessary to feed the tool out with the cross screw after reaching the end of the cut. To enable the operator to bring the tools back to turning position, we made collars *A*, Fig. 4, which fitted the screw between the hand-wheel and the carriage and were split so that they could be tightened by a clamp screw. A hole was drilled into the front of the carriage in such a position that a sliding pin fitted to it would act as a stop for the pin in *A*. In use, after getting the tools set for turning, the collar was turned around until the pins touched and tightened. When we wished to do the facing the sliding pin was pushed in out of the way, and when it was desired to return the tools to turning position, the tool block was run back to within one turn of the screw, the sliding pin pulled out, and the screw turned until the pins touched. These tools, with the aid of a large can of havilene fitted with a screw-machine drip, did a very satisfactory job on the long end of the piece. The diameters were turned 0.0005 to 0.0015 over size, and after finishing this operation, the shoulder next to the collar was filed to a ring gage, the work being held in a collet in a bench lathe for filing.

For turning the eccentric end the tools worked the same as on the long end, but the end was not supported by the tail center, and instead of the special dogs the piece was held in the fixture shown in Fig. 5. This fixture was located on the faceplate with the correct amount of eccentricity and doweled. The hole was made to fit the shoulder that had been filed and the binder screws had brass shoes under them to prevent marring the work. In setting the work the piece was inserted in the hole and shoved back until the collar touched the fixture, the leaf was swung down, the work turned until it touched the leaf, the screws tightened, and the leaf swung up out of the way.

We had in the department only two lathes with automatic knock-off on the feed rod. These we used for turning the first end. For the eccentric end we had to rig up knock-offs on the machines selected which were screw-feed lathes with a tumbler gear in the head for reversing the feed. Fig. 5 will give an idea of what we did to them. The operating pinion of the left-hand feed was removed from the rocker, rendering it inoperative. The handle of the rocker lever was flatted off on two sides to give a working corner for the latch *B*, which swung on a pin in

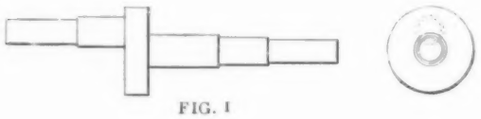


FIG. 1

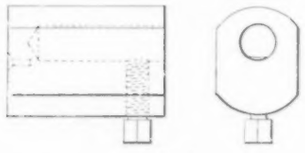


FIG. 3

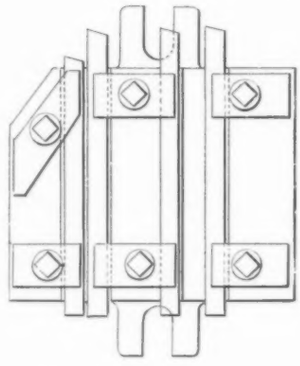


FIG. 2

THE WORK, THE DOG AND THE TOOL-HOLDER

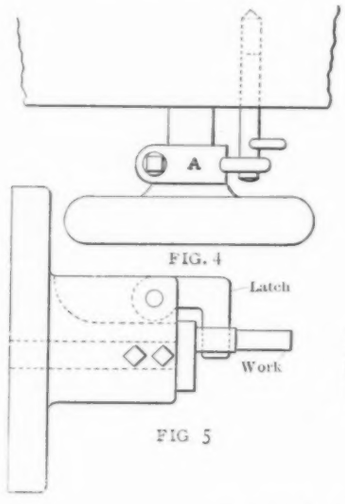



FIG. 4

FIG 5

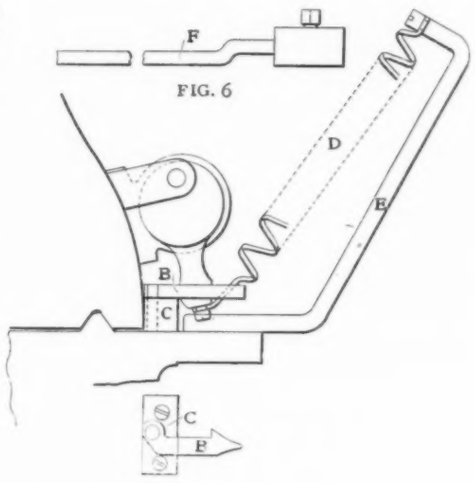



FIG. 6

THE CHUCK, THE STOP AND THE KNOCK-OFF

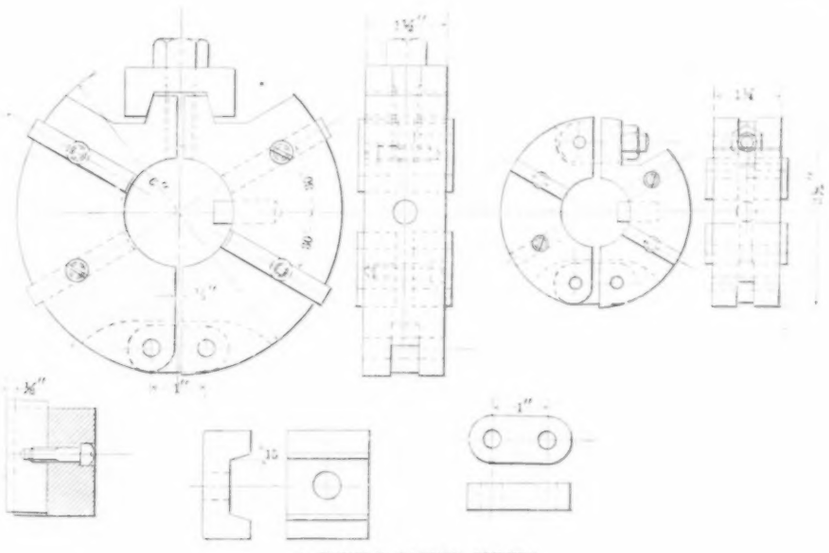
the block *C*, which was fastened to the bed. A tension spring *D* connected on one end with a screw in the end of the rocker lever and was held on the other by the angle iron *E*, which was screwed to the bed. The block supporting the rod *F* was fastened to the carriage. When the feed was in, the lever was thrown down and latched. To knock off the feed, the rod *F* was set to strike the latch between the lever and the fulcrum pin of the latch at the proper time, when the latter would release the lever which would be pulled upward by the spring, throwing the gears out of engagement. This apparatus was so positive and so satisfactory that we used it afterward in preference to the lathes with the regular knock-off, which were of the type which have a telescoping pin clutch on the feed rod.

After the turning of the shafts was finished, the various diameters were filed to ring gages, being held in special chucks in the bench lathe. The labor cost on the pieces, including drilling and tapping a small hole in one end, was eight cents each and the tool cost averaged about as much more, so that the total labor cost, including setting up and supervision, was less than 20 cents each. We considered the outlay on tools well repaid.

New Haven, Conn. E. A. JOHNSON.

## A Double Facing Cutter

The accompanying illustrations show a double-end facing cutter which supplies the need of a rigid, quick-setting tool that is not obtained in the common straight cutter.



A DOUBLE FACING CUTTER

On the larger size the body is cast in one piece, and bored out to a neat fit for the boring bar. It is then turned up and the slots put in for the cutters and hinge, and also shaped out for the clamp. The hole for the clamping screw is tapped before sawing apart. The slot in the clamp is made small enough to draw down and clamp the boring bar. The clamping screw is threaded about 0.01 inch smaller than the tapped hole. The cutters are made of high-speed steel and fastened from the back with a fillister-head screw. The application of the cutter is shown in the small section. The cutter is driven by a case-hardened pin pressed into the body of the cutter, and engaging in a hole in the boring bar.

The smaller cutter is made of a low-carbon machinery steel and can be clamped as shown. The object of this style of clamp is to have no projection outside of the circumference of the cutting edge, so as to allow of work inside of a cored hole, or up close to a projecting arm.

Another advantage of this cutter is the strength that can be retained in small or large boring bars for heavier cuts than if the cutter were put through the bar and fastened with set-screws.

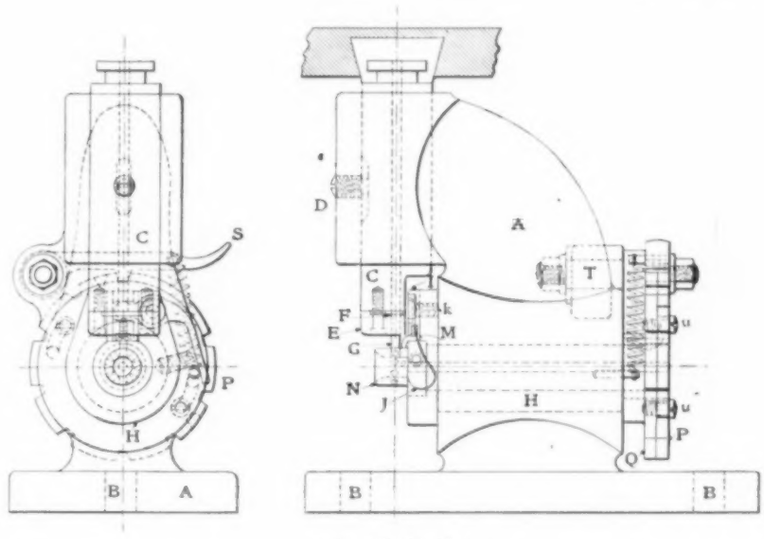
The holes weaken the bar so that the torsion frequently breaks it, if it has more than one set of holes, whereas this cutter only requires a shallow hole in one side of the bar.

This style of cutter has been made and used by the Landis Tool Company, Waynesboro, Penn., and has proven very satisfactory.

Waynesboro, Penn. C. P. H.

## A Sub-press Die for Punching Holes in Steel Rings

The sub-press die illustrated was designed to punch 0.100-inch holes in steel rings through metal 0.050 inch thick. Drilling 10 holes in a ring with a drill jig was thought to be too slow an operation. So it was finally decided to try




A SUB-PRESS DIE

punching, which has proven very successful so far, and could still be made to operate more rapidly by having an automatic revolving feed connected with a cam from the press shaft.

The sub-press proper *A* is of cast iron, planed on the bottom, with two holes *b* in each end to secure it to the press bed. A 1¼-inch hole is bored and reamed vertical in the sub-press *a* a snug fit for the punch holder *C* which is held in position with a hardened screw *D*. In the center of the holder a 3/16-inch hole is bored and reamed central with the outside. This is made in order to drill and ream all the holes in the die while assembled. On one end the holder is made T-shape to fit the T-slot in the ways of the press, on the other end is turned a shoulder and recessed in the center a snug fit for the shoe holder *E* and shoe *F*, which is hardened so as to make it a solid seat for the punch *G*.

A 1½-inch hole is bored and reamed horizontal in the casting *A* to fit the die-holder *H*, which is bored and reamed central with the outside to fit the die. A dovetailed groove is milled to fit the slide *I*. In this slide a slot is milled to fit the handle *J* which swivels on a head-

screw *k* and is held down in position with a pin in the handle and a spiral spring. Located in the die holder in the bottom of the slide is fastened a locating finger *M*. The die *N* is driven in the die holder and flattened on one side of the shoulder end to make a seat for the slide *l*; in the center of this end fits a center plug *o*, which is driven in just beyond the punch hole so that the punchings will drop right out of the way. In the bottom of the die in its center is a ⅛-inch hole drilled so as to be able to knock out the center piece *o*. The other end of the die holder and index plate *P* and *Q* are located and keyed inside, while the outside plate is a turning fit on the end, and held in an elongated slot and fastened with two screws; this is done for the purpose of punching rings with 5 holes as well as rings with 10 holes by merely covering over 5 index grooves by unscrewing the two screws *uu* in the elongated slot, and turning the plate *P*. Indexing finger *S* hangs on a stud *T* fastened with a nut to the casting and held down with a spiral spring, with a pin in the index finger.

When the die is finished and assembled, the die holes are spotted first with a center drill by using the index plate with 10 grooves, and later drilled and reamed with the same setting. A short taper-reamer is brought in from the center hole and reamed up from the inside by hand for clearance. The die is then taken apart and hardened. In order to hold the ring on the die when punching, a separate hole is punched first close to the edge by placing a ⅛-inch thick ring between and lifting the locating finger *M* up and letting it rest on this ring while the first operation is punched; after that is done the ⅛-inch ring is taken out and the regular ring with one hole punched in it will fit the locating finger *M* and hold the ring in position while the 5 or 10 holes are punched. R. A. ALMOND.

Hartford, Conn.

## Inserted-tooth Cutters for Milling Aluminum

During the last few years the use of aluminum has developed enormously, especially since the advent of the motor car. This has played an important part in the design of some of the present day machine tools, which are intended to operate on aluminum, as well as iron and steel. Take the milling machine as an example, which is undoubtedly used to a larger extent on aluminum than any other machine tool at the present day. To reach the highest efficiency with that machine when used on aluminum, it is essential that it should possess a far greater range of feeds and speeds than is necessary when it is intended for use on gray iron and machinery steel only. With aluminum, quite four times the peripheral speed, and double the feed used for iron or steel, are usual practice.

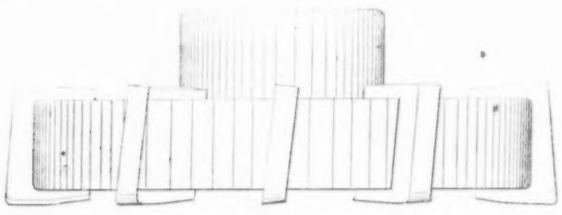


FIG. 1

FIG. 4

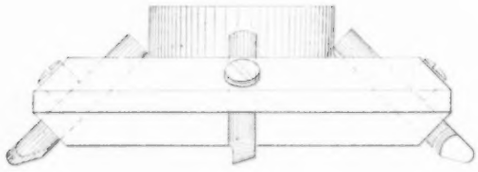


FIG. 2

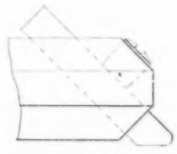


FIG. 3

INSERTED-TOOTH MILLING CUTTERS

Fig. 1 shows an inserted tooth-milling cutter, which is one of the most common types in use on gray iron, where it gives very excellent results; it is also used to a large extent on wrought iron and machinery steel, but is not as successful on that material as gray iron, as the cutters, as a rule, have not sufficient front rake (usually from 5 to 7 degrees) to produce a smooth finish. This type of cutter is unsuitable for aluminum, due to the material being softer to work, than iron or steel. The cuttings, or chips, get wedged under the cutter blades and produce a very rough surface, no matter how it is lubricated.

The type of cutter shown in Fig. 2 gives excellent results on aluminum, and is strongly recommended. The cutters not being called upon to perform such heavy work as when used on iron and steel, can be given a greater amount of rake as shown; we give them 45 degrees from the vertical. The chips are then thrown quite clear of the succeeding cutters, and do not crowd under the points of contact. This cutter will produce a beautiful, smooth finish, if the work is lubricated with paraffin. The cutters are held securely in position by the large headless screws shown, tightened up with a lever screwdriver. This is a great advantage, as with the cutters revolving quickly, projecting screw heads are very dangerous, and should be avoided wherever possible. Fig. 3 shows another type of cutter, which is very similar to the one shown in Fig. 2, with the exception that the inserted cutters in Fig. 2 are made out of round stock, whereas those shown in Fig. 3 are ½ inch square. The holes for the securing screws are first drilled and tapped 1 inch diameter, the cutter head is then placed on a universal milling machine, and the cutter spaces gashed out, ½ inch wide, straight across the centers of the screw holes; the bottom of the gash is indicated by the dotted line *x*.

Fig. 4 shows a cutter head similar in construction to Fig. 2, but much smaller and designed to carry one cutter only, for use on narrow edges, and restricted spaces in motor-car gear boxes, etc. The cutter is secured by a set-screw in the manner shown; it is thoroughly efficient, and capable of doing a large amount of work, much of which might otherwise have to be done by hand.

Cutters designed for operating upon aluminum should have the teeth pitched farther apart than when designed for gray iron or machinery steel, as they require more clearance for the chips to get clear away, and each tooth can take a much heavier cut than in iron or steel. We find that for cutters up to 4 inches diameter three teeth are quite sufficient. A greater number is unnecessary and the chips do not have time to get clear. From 4½ to 6 inches diameter, we use four cutting teeth, from 6½ to 8 inches, five teeth, 8½ to 10 inches, six teeth, 10½ to 12 inches, eight teeth, and when using the larger size cutters, run them at a peripheral speed of about 580 feet per minute, with a feed of from 9 to 12 inches per minute, according to the depth of cut. At these feeds and speeds the cutters will stand up to their work perfectly, and produce a very excellent finish on aluminum work in general. SYDNEY LAWRENCE.

Coventry, England.

## Scale with Decimal Equivalents

I have taken an ordinary 12-inch scale such as can be bought here for a shilling and on the plain side have etched a table of decimal equivalents by 64ths.

Of course these are usually found on micrometers and in catalogs, but the time a man usually wants them is when using a scale and these are always handy.

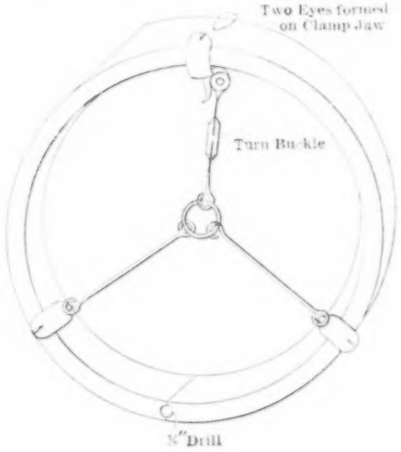
Coventry, Eng. A. E. C.

## Making Some Iron Rings with Limited Tools

We had the job of making some iron bands from 3x1-inch bar iron bent to a circle the flat way of the stock and measuring from 24 to 40 inches inside diameter.

We could bend this size all right, but when it came to welding and making a clean and strong weld, we did not have a large enough forge or a skilled man at the fire to do it.

After making a couple of rings and finding them defective for a good finish at the weld, we decided on this plan which was a great success, and also a very quick and easy way out of it. First we bent the stock to the required circle and then measured it carefully inside allowing for tool finish and the size of the weld, then the butt ends were squared fairly and brought end on end—clamped in this posi-




MAKING THE IRON RINGS

tion and a hole drilled about ⅞ inch diameter entirely through. A plug was then turned from good iron 1 inch diameter and about 3 inches long.

Then we sprung the ends of the bent stock apart and after a thorough cleaning of the drilled part inserted the plug.

A clamp from three points served to hold a tension on the joint after it was heated, and by gradually bringing up on the clamps the ends of the ring were forced up and surrounded the plug.

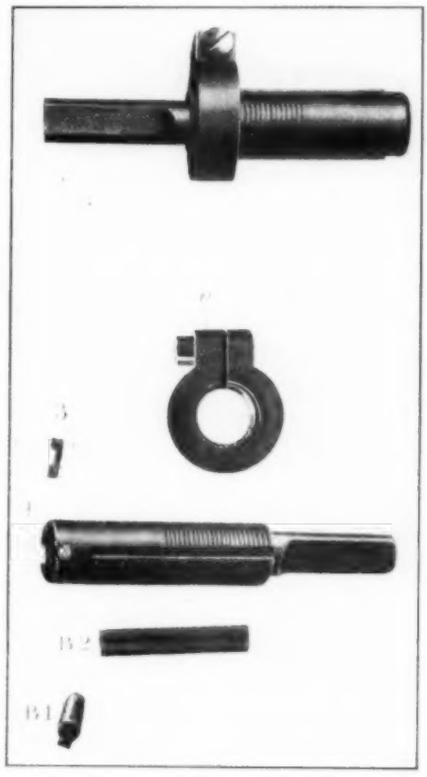
At a welding heat it was taken from the fire and lightly tapped with a hand hammer, bringing the lips of the joint down and forming a perfect weld, clean, square, and free from burned iron and wasted spots.

It may be interesting to follow the time of this job, so I will state that from flat-bar stock one man and a boy helper could produce, and did produce, 50 rings at the rate of four per day of 10 hours.

East Orange, N. J. E. O. J.

## An Adjustable Washer Broach

A broach for double-grooved brass washers which has given excellent satis-




AN ADJUSTABLE BROACH

faction after two years' service is shown in the illustration. The washers have a ⅞ hole and the grooves are ⅛ inch wide and ⅛ inch deep and are placed exactly opposite each other. It is important that these grooves or slots be kept exact size and so some form of adjustable broach was thought advisable.

Fig. 1 shows the tool assembled and ready to use. Fig. 2 shows the separate parts six in all, including the clamp screw. The body of the tool is made as shown. The slots for the blades are made to run deeper into the metal as they approach the shank so as to not only afford clearance, but means of adjustment when the blades *B B* are forced forward by collar *A*. A hole 4 is drilled for pin 3 against which the ends of blades are butted.

The blades are made as shown at *B*, Fig. 2. Some discussion has been caused at this point as to whether to make them this shape or in the form of a dovetail. The form shown was finally adopted as being easier to make. At first the dovetail plan looks easier, but on careful study I think the circular body preferable, both for ease in making the blades and the broach body grooves.

When the blades dull or lose size they are taken out and both ground exactly the same length and when they are put in again and snugly tightened between pin and collar we have the original size again.

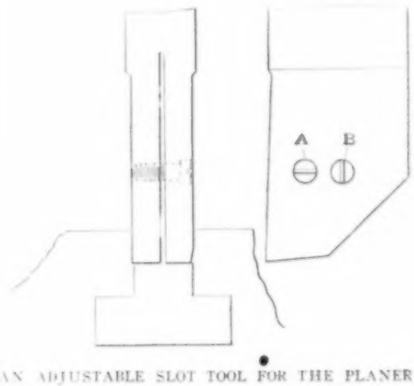
Of course the broach body is hardened, and here is where the circular holes show up in the ease with which they are lapped to size. The straight milled slots are also easily lapped. The shape of the blade makes it far less apt to warp than the dovetail type. These and a number of other good points show up not only in the making but in the use of this broach.

Decatur, Ill. ETHAN VIALL.

## An Adjustable Slot Tool for the Planer

The tool is simply a square-nose tool split up the center about 2½ inches with a 1/16-inch saw, and with two screws. *A* is a ¼-inch fillister-head screw tapped into the left side, *B* is a ⅜-inch headless screw tapped in the right side, being used to spread or adjust the tool to size, while the other screw holds it locked when set. I have tried several tools of this class and think this one the best.

It may save some other man trouble




AN ADJUSTABLE SLOT TOOL FOR THE PLANER

or inconvenience to know how *not* to spoil a slot with a square-nose tool, and that is to be careful to see that both corners of the tool are equally sharp, for if one corner becomes a little dull that corner will be crowded off and the tool will scrape more from the other side of the slot, as shown in the illustration.

As this tool is intended for very light cuts only, it doesn't require much heel and can be ground off on the end with less time and chance of over-heating on the wheel.

Cleveland, Ohio. H. L. C.

## Use of a Micrometer Head in a Jig

Fig. 1 shows a type of a jig used with good results in the shop where I am employed. This jig is quite a simple affair and my object in showing it is that it may possibly offer a suggestion for the use of the micrometer head for similar work.

Fig. 2 shows the tool holder for which the jig was designed. This tool is used in an automatic machine in making clock pinions. Its office is to face or finish the sides of the small brass disks, after they are driven on the wire. There are quite a variety of pinions in a clock, and likewise quite a variety of clocks, which means, of course, a number of tools with slots for the blades located to suit each particular pinion.

The tool as drawn shows three blades, facing complete two disks at one operation. Ordinarily two operations are required to do this, the first operation being to face one side of both disks, the second operation to face the other side. If they were to be faced complete in one operation, the disks would be liable to slip on the wire and thereby become loose. The tool as drawn, however, serves to illustrate the different conditions that have a bearing on the design of the jig.

Blade *A*, in Fig. 2, shown facing the left-hand side of the work, is set in at an angle of 2½ degrees to allow the blade to clear; blade *B* is set in straight and blade *C* is set at an angle, in the opposite direction from blade *A*, facing the right-hand side.

The jig, Fig. 1, is made with three removable blocks *E*, to conform to the different angles of the tool slots *A*, *B* and *C*, Fig. 2. The distance *F* on all blocks is alike, in order that the corner *J* shall line up with the side of the hole in the sliding guide bar *G*, where the micrometer is at zero.

When a new tool holder is wanted, a blueprint is taken from a standard bond-paper drawing that has black spots for the dimension *H*. The black spots print white, of course, and the proper dimensions are entered on the prints in ink, by the draftsman.

The driller, after clamping the proper block *E* in position, sets the micrometer to the dimension given on the drawing, clamps the guide bar in place against the micrometer and the rest is easy.

There are two holes in the sliding bar *G* exactly 1 inch apart, so that when dimension *H* comes over 1 inch or beyond the range of the micrometer the second hole is used.

The same jig is very nicely used for the slotting operation, which is done by a Brown & Sharpe slotting attachment on the milling machine. The guide bar and micrometer head are removed and the jig is clamped to the table, the holes previously drilled serving as guides for the slotting operation.

G. D. H.

Boston, Mass.

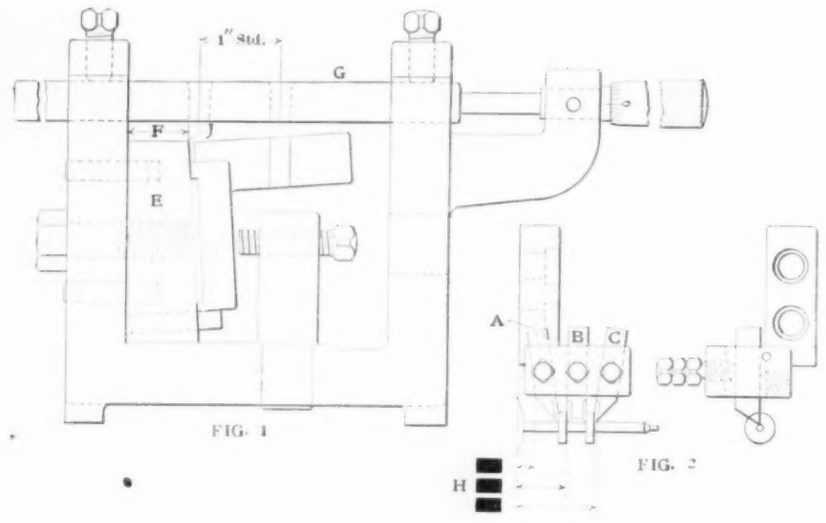



FIG. 1 FIG. 2

USE OF MICROMETER HEAD IN A JIG

## A Facing Bar

The illustrations show a device for facing or counterboring a seat for a bolt or nut on the opposite side from which the hole is drilled, when using an air or electric machine.

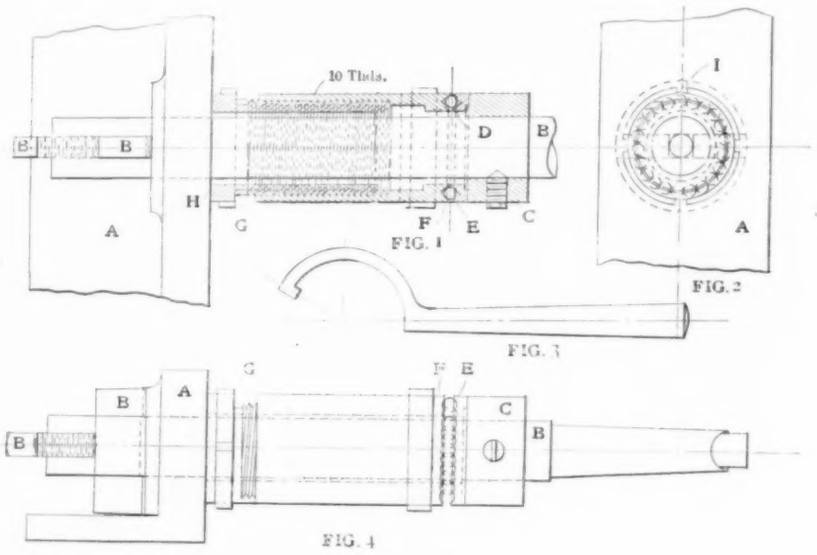



FIG. 1 FIG. 2

FIG. 3




FIG. 4

A FACING BAR

I had a job where there were a great many holes to be drilled and faced in some large castings, and could not do it on any drill press, so we used an air machine and faced them off with facing bushing, and it has been used for this class of work for over a year by men in the shop, and saves a great amount of time.

*A* is the work; *B* is a 1¼-inch stub boring bar double end facing cutter held in place with a ½-inch set-screw; *C* is a collar, held by a set-screw to the bar; *E* is the upper half of the ball-bearing washer recessed to fit the shoulder end on the collar with the ball race on the other side cut on a 45-degree angle.

*F* is the nut and the other half of the ball race. It has slots cut as shown in Figs. 2 and 4 to fit the spanner wrench shown in Fig. 3.

The two halves of the ball race are held together by the ring *D*, made of 1/32-inch copper. Both halves should be hardened. *G* is the base and is slotted to fit the spanner wrench the same as *F*, and should be hardened at *H*.

The parts *E*, *F* and *G* should be made of tool steel. Quarter-inch balls are used. One of these arrangements can be used on several different size bars by making different size collars.

Washington, D. C. H. T. L.

# Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

## WE PAY FOR THESE ALSO

### Public Industrial Schools

In the AMERICAN MACHINIST, on page 256, appeared an article entitled "State-supported Trade Schools," which was a résumé of the sentiment of the meeting of the National Society for the Promotion of Industrial Education at Chicago, as it appeared to the editor. This was expressed in the following words: "To sum the matter up, we believe the entire plan of State-supported trade schools must be dropped and the quicker the better."

This seems to me to be a statement of policy which, if accepted in its entirety, is most prejudicial to the whole spirit of American progress. Possibly the conclusion, as voiced in the editorial alluded to, was reached without a clear conception of the fundamental idea underlying the movement toward industrial education. It is the aim of this article to illuminate one or two of the seemingly misunderstood features of the situation.

If American development has done anything it has demonstrated beyond question or cavil the absolute desirability of unbiased and unrestricted educational opportunity. At its inception emphasis was laid, and rightly so, upon a certain classical curriculum which at that time was adequate to the needs of the community; until recently all expansion and subdivision have been along lines laid down by our progenitors. But a turn of the tide has come; the characteristic of American life is adaptability; actions conform to the circumscribing conditions. Modern tendencies more and more indicate acceptance of the hypothesis that all activity of any description whatever is some form of energy transformation. It should be recognized as such and so investigated and studied. The dawn of a day for understanding, for reasoning and predicting, rather than memorizing, or imitating, or blindly trusting is at hand; it is so because the time is ripe for it. With our fathers was the opportunity for work in the virgin soil of an unbroken field, but with us the means of subsistence lies in intensive farming.

Much of the difficulty in considering this subject arises from a misunderstanding of technical terms and failure to cognize basic principles.

Trade schools are not manual-training schools, and manual-training schools are not industrial schools, nor should the first be confused with the latter. What a school is, is determined by its underlying motive. If the three types of school are examined on this basis, taking proper account of the peculiarities due to the locality in which each may be placed, a conclusion regarding the most suitable designation for an industrial school may be correctly drawn.

A manual-training school is an institution where there is given a general training with a wholly cultural object. The intellect is developed and the eye trained, aided by work of the hands, hence the name "manual training." The underlying motive is culture; not a development of dexterity of hand or an acquisition of mechanical experience commercially salable. The manual-training school came into being as a means for relief from conditions existing previous to its establishment, and which also obtain at the present time. The high school offers courses of study which are college preparatory and others which are simply cultural. Young men came to recognize this; those who could not afford a college education sought training for a life work in the vocations, and the manual-training school in its original conception was an attempt to supply this demand. That it fails in doing this is no inherent fault, but shows it has grown away from its original mission. It is at the present time an important step in the preparatory education of the youth who attends the engineering colleges and schools of technology. Its original motive of diverting its graduates to the trades is not exemplified in 1 per cent. of its attendants.

A trade school, on the other hand, has for its sole and only object the instilling of the principles of a trade—of *one* trade, if you please—and of developing by continued practice a manual skill and efficiency which will assist their possessor directly in acquiring a living through such practice. Only the bare trade is taught, and often that not thoroughly; associated academic subjects are not touched upon; no intimation of the relation of that trade to any other is made. The inevitable result is a narrow-minded, intolerant mechanic, who excites the ridicule of the craftsmen with whom he seeks to associate, who brings discredit to the system of trade education because people, seeing him and not appreciating the difference between a trade school and an industrial school, conclude that all industrial training is of a similar nature.

An industrial school partakes of the feature of the two schools just referred to with important items in addition. It instructs in the mechanical practices, and in the broad principles underlying all crafts. It seeks to instil, first, an appreciation of basic principles; then, to develop a certain manipulative skill at the same time undertaking an active mental training. When sufficient judgment has been attained to enable an intelligent decision, a certain trade which he desires to learn, is selected by the student and studied in all its essential particulars; its history, the portion of the sciences of chemistry and physics which pertain to it, the materials with which it deals, their production and manipulation as well as allied subjects would be thoroughly considered. When the school has given a satisfactory preparation the student will go to work at his trade in some shop. And in time he will become more competent, intelligent and efficient than any trade-school workman or graduate of a manual-training school can hope to be.

To recapitulate, a manual-training school is today a preparation for an engineering college; this may not be admitted, but such nevertheless, is the whole and only reason for its existence. It is a preparatory school, forming an intermediate step in the direction of higher education. The trade school prepares a man more or less thoroughly for the practice of a trade and of one only. It affords no opportunity of preliminary survey and intelligent selection of the most congenial trade; the one in which success is most probable. In other words, it *trains* in a single thing and does not broadly educate. Whereas, an industrial school affords opportunity for education and development in the broad principles underlying all crafts, and finally offers specific instruction in a single one selected rationally and intelligently. It is no short cut to a trade. Its graduates will not be all-round journeymen nor specialists, any more than the fledgling M. D. is a competent physician. They will be, however, men who have an intellectual foundation upon which may be erected through intelligent application and practice a superstructure of worth and efficiency which can never be possible to the man less well prepared.

Let us look at the matter from still another point of view. As has been said before, the manual-training school is but a single step in an educational succession. It has a certain amount of elemental shop work which trains both hand and eye to the extent that it enables a student to put a button on a barn door, or repair

broken furniture and to learn the names and uses of some of the more common tools, but its chief object is not the giving of commercial mechanical instruction.

The trade school is a shop having no academic department; it is an end in itself. Its object is not to educate; it is only to train a man to operate a certain machine at its maximum output, thus earning for himself with minimum preparation the greatest possible compensation in that capacity. Such an institution meets and merits the condemnation of the employed and of the better class of employers.

The industrial school holds class room and shop to be of equal importance. It plans to educate while it trains; it is not an end in itself. It does of necessity train in manual dexterity and manipulative skill, and coincidently it develops the powers of observation, of differentiation and of correlation which are essential to growth in the chosen direction. Because of thorough grounding in first principles and progressive harmonious development, it is obvious that such a school would not attempt to foist upon the labor market a lot of half-baked mechanics who, by their inefficiency and worthlessness, would defeat and negative the purpose of the school. Only when pupils had reached the point where something beyond, or perhaps different from the school was desirable, would they be sent out to the commercial shops to get a job; not as full-fledged mechanics, by any means, but rather in their true capacity of embryonic craftsmen of great possible potentiality. These men would in the daytime employ themselves in shops and for two or three evenings a week would return to the school for additional instruction, thus insuring constant progression in lines already laid down. The twofold advantage of such a system is at once apparent: to the mechanic by supplementing his knowledge and skill and consequently his earning power; to the employer by furnishing him better help. There is no quibble concerning the wage of a really efficient workman. Such men would not pull down wages, but would tend to raise them. They would be a credit to any organization with which they chose to affiliate themselves.

The writer believes the industrial school proposition will not be dropped either speedily or eventually. It has come to stay because it is demanded; the need for it is imperative. Such questions as the attitude of organized labor and capital, the disposal of products and similar subjects are much discussed and already satisfactory conclusions are being developed.

In a civilization which demands equal right and equal opportunity for all and which guarantees every man a fair show, can it be said, either in justice or in reason, that there shall not be given to the boy who has to work as fair an opportunity for preparation for usefulness in a vocational life work as the college preparatory schools now offer to those who can afford continued years of study.

TRUMAN D. HAYES.

Cambridge, Mass.

## Apprenticeship

The letter by "Entropy" on page 60, under the above caption, reminds me of a boy I once knew, and an analysis of his experiences in becoming a mechanic is interesting as it furnishes a concrete illustration of the fact that even the smallest details often have far-reaching effects.

His father, as per "Entropy's" story, was the patternmaker and draftsman at a small manufacturing plant in a New England city. Observation had shown him that the machinists in that shop didn't work as hard as they thought they did, so he decided to make his boy into a machinist. Perhaps he discerned a tired streak in the boy's nature of which the boy himself did not know; anyway, he informed the youngster that he was going to apprentice him to a good shop as soon as he found one.

### APPRENTICESHIP

At that time the boy was working in a textile finishing plant for $1.25 a day and the extreme hight of his ambition was to become a writer. He had no very definite idea as to what kind of a writer; but as most any kind would do he saved all the money he could for future educational purposes, and hoped. In the meantime he had become a fairly good cornet player in the local brass band. Beside taking lessons on the cornet, he was studying harmony and composition and arranging for bands and orchestras. In this connection he soon began to write for various musical journals; reporting concerts and writing articles on music in general. Then came the announcement of his apprenticeship to a firm of machinery builders for a term of three years under a $200 bond to stay out the time, and at a wage scale of 50 cents, 75 cents and $1 per day for each of the three years, respectively. This didn't suit him at all, as in his opinion any old boy could be a machinist; but parental authority was absolute so he became an apprentice.

Under the new wage scale money was scarce and the musical instruction was dropped, although the knowledge already gained was utilized and a slow advance made all along the line. During the second year he received several jobs of piece work that helped the depressed financial situation and the musical instruction was resumed. Naturally this frantic interest in something so extraneous to the trade did not tend to promote his mechanical abilities, even if he had any to promote. He was always a careful boy and as a result he got along with the foreman and spoiled very little work. When his term of apprenticeship had expired he knew how to do quite a variety of work on the tools he had used, do it well enough to pass inspection and do it in a reasonable time. That was all. He had never learned to think mechanically. He had never run a milling machine or a grinder; a shaper, or a horizontal boring mill; his experience at bench work consisted in hand centering about two barrels of bolts during his first weeks in the shop. He didn't know how a cam was laid out and cut, and he didn't care a rap whether he did or not. He did know how to get out some work, large and small on the lathe. He had heavy planer and vertical boring-mill work down pat as far as his experience had gone. He also knew that his three years "time" was out and that he was entitled to a job at 18 cents per hour. Taking it all in all he was just an average ordinary boy.

### NEW FIELD

Three months later saw him as reporter and advertising solicitor on the staff of a country newspaper and as space writer on a big city daily, correspondent from the country county seat. This didn't come up to his expectations and in about a year he migrated to the city and became solicitor and advertisement writer for a concern doing fine printing and catalog work. Then he caught the fever of the "Golden West" and shortly afterward turned up in Los Angeles, California. After a brief sojourn there, during which he failed to become managing editor of any of the city dailies, he wandered out into the desert and was next heard from, I believe, laying a pipe line for the stamp mill of the Golden Cross mine, near the Arizona line.

About a month after that he assisted in the production of one edition of the *Gila Bend Leader*, at Gila Bend, Arizona, said assistance consisting of his operating the lever of the hand press for an hour or two, while the editor-in-chief placed the sheets on the type and removed them when printed. Shortly after that he was learning the details of railroad-track construction and repairs in a section gang at Tuscon. I believe he never got beyond the "blister" stage, which was about two weeks. Then the gang foreman told him in plain, but emphatic language, "Yez is no good! Yez was borned with a silver spoon in yez mouth and yez can't never learn to use a pick and shovel."

Next he was leaving El Paso, Texas, with a man named Wheeler who had hired him to run a hoisting engine at his (Wheeler's) mine at Chihuahua, Mexico. He had never run an engine of any kind, but he had his nerve with him and was willing to try. Something had happened at the mine, however, during Wheeler's absence and it was closed. Therefore the boy returned to El Paso just in time to take part in a "McGinty Club" concert.

### BACK TO THE OLD TRADE

After some more of the strenuous life,

at the end of which he was engaged as second cook in a German restaurant at San Antonio, he saw an advertisement one day to the effect that machinists were wanted at the shops of the G. H. & S. A. R. R. and that 35 cents per hour would be the compensation. As this was his first chance to use the despised trade that had cost him three years of "doing time" he at once hunted up the railroad shops in question. He asked for the foreman who, when found, inquired gruffly "Where's your traveling card?" The boy hesitated; "Traveling card," he said, "I haven't any. I don't belong to the union."

"Then get out of here," said the foreman. "We don't want any scabs in this shop."

"But," explained the boy, "I served my three years at the trade."

"D—— you and your three years," replied the foreman. "If you go to work in this shop you'll have to belong to the union and don't you forget that."

"I'll see you and the union in a hotter place than San Antonio with the blower on before I do," answered the boy and he went back to his cooking job at the restaurant, thinking things about a trade he had worked three years to get and couldn't use unless he did what some more men with that same trade said he must do. For the first time in his life he felt that he wanted to work as a machinist and he made a vow to himself that he would work and would get higher in that trade without the aid of, and in spite of the union. And he did.

For a number of years now he has been a successful foreman in different plants and shops in various parts of the country, but it took hard work, much reading, night study and a close application to his business to do it.

East Greenwich, L. I. A. A. PRINER.

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From time to time there have appeared in these columns numerous articles regarding apprentice systems. The majority of these were focused on practically the same point; "does it pay?" After reading Mr. Alvord's candid experiences on page 205 and summing up his conclusions I have yielded to the temptation to "put in my oar."

### APPRENTICESHIP SYSTEMS

I am in touch with one of the largest and best apprentice systems in this country. I have been interested particularly in its different phases, its good results, its shortcomings, so I feel qualified to offer a few words on the subject. From Mr. Alvord's article I should judge that the work done in his factory was not wholly close, accurate work; therefore, his troubles are lessened proportionally. I question seriously if he could take his "doubting Thomas" and with any amount of patient effort teach him to construct a complicated piece of machinery, or build a compound die. It isn't "in" him. He could not be expected to prove a success on such work however slow the process of evolution.

In cases where all that is wanted is a plain machine operative on multiple work, such as drilling, milling, turning or planing, where a man does from one week to the next, but one simple operation, or at most five or six, I can see no need of any apprentice system whatever. In such cases the work is usually, or should be, piece work, whereby spoiled work and lack of speed are at the expense of the operative. In such cases I can agree with Mr. Alvord that promotion from the snagging-room and ranks of the helpers is commendable.

### SELECTING MATERIAL

There is more depending on the choice of material from which to make machinists than some imagine. This apprentice system to which I have alluded gives each boy of promising appearance a month's trial, during which he is under the personal supervision of one apprentice expert whose decision accepts or rejects him at the end of the month. By this method alone this company saves hundreds of dollars worth of training, which might be expended on a boy who will sooner or later find his level as a truck-driver or in some similar capacity. By this method Mr. Alvord's Arthur would have been eliminated from the system, unless the carelessness could have been eliminated from Arthur.

As a previous contributor has said "There are machinists, and then there *are* machinists." The better ones are in the minority. The scarcity is always among the skilled toolmakers and diemakers. You will find this statement verified if you will look through the advertising columns of this paper or any of the large dailies. It is the skilled all-around machinist whom we are trying to produce; we are already over-supplied with the ordinary machine operative.

### REASONS FOR LEAVING SHOP OF TRAINING

The reasons why an apprentice leaves the shop that taught him his trade are many. First and foremost, he is offered more wages elsewhere. It is only natural that he should desire to improve his condition, financial and otherwise; we must all of us admit that what the pay-envelop holds for us is the principal feature of our satisfaction or dissatisfaction with our station in life. Again he may wish to broaden his experience, to become more expert along certain lines, possibly to engage in business for himself; all of these are good reasons, although they look better from his standpoint than from ours. This first reason is undoubtedly accountable for 50 per cent. of the losses in trained apprentices. I can see no reason why the boy we have brought up on our work, accustomed to our requirements and conditions is not worth to us as much or more than he is to anyone else. Why then should he not be treated as well as the machinist we hire from outside and pay good wages to for the same work? The answer is, although we are not conscious of it we regard this young man who is through his time as a boy; our eyes do not see him in the same light as our competitors. We remember the mistakes he has made and forget, or at least our mind does not give him credit for, all the good work he has done; the new man comes to us as a sort of a mystery; we are willing to "take a chance" on him.

Let me illustrate by a true example. Paul came to a shop which took in many apprentices to learn the machinist's trade. He was bright, and worked successively in nearly every part of the factory on the various machine jobs, floor work, repairing, and die-work. The end of his time found him in the tool-room on the highest type of fine gage work. He was given $2.50 per day as a journeyman machinist. For a while this seemed good pay to him compared to his former apprentice pay and he was contented; but like Mr. Alvord's Charlie he got married. As his expenses increased he asked for another 25 cents which was given. After he had been out of his time two years he considered that he had earned another increase, especially as the men around him were getting from $3 to $3.50 per day. He asked for $3 which was refused. He had already looked around, so upon being refused he accepted a job in a neighboring city at $3.50 per day. There isn't one of us that can blame him. The man who took his place gets $3.25. As I have stated the reason for this change was that in the eyes of his former employer he was only a boy; his new employer recognized the man in him.

It is an established fact that the boy who leaves the shop where he served his time and returns after a few years can command better wages than if he nad worked there continuously. Most of the boys who leave a shop to gain experience come back finally to their "Alma Mater," and invariably at good wages. The boy just out of his time is a good asset to any machine shop; he is on the *qui vive* to make every job a success; he is full of ambition to get ahead, and it seems to me he should be paid good wages, not from any philanthropic reason but because "it pays."

Beverly, Mass. P. E. NOYES.

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Most fluxes used in melting brass attack the crucible and cause all sorts of trouble. Glass has been used to some extent for this purpose by rolled brass manufacturers, who are able by this means to reduce the spelter loss to below 1 per cent. One reason for the success of glass as a flux is that it does not become actually liquid, and hence does not attack the crucible. It becomes pasty, and is readily skimmed off, this being a difficult operation with a liquid flux.

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## The Precision Level

By a happy coincidence we are enabled to present on another page a collection of three articles on the use of the precision level, these articles supplementing one another in an admirable manner and without duplication of the ground covered.

In reading this article the reader should disabuse his mind of any conception which he may have of the instrument obtained from the common or garden level, as used by masons and carpenters. The levels referred to in these articles are of the same grade as those in use on surveying and astronomical instruments and they are fully entitled to be called precision tools—a fact which is indicated plainly enough by Mr. Libby's statement that his level reads to a quarter of a thousandth of an inch in a foot.

Levels of this character have a wide degree of usefulness in the machine shop and one which is only just beginning to be appreciated. We have much to learn from Germany in this respect, as the instrument is far more widely used there than here—a fact which is no doubt due to the great development of work in pure science in Germany and the consequent development of instrument making of the higher grade. Because of this the high-grade level is a much more familiar affair there than here, and its uses in the machine shop have come to be more quickly recognized.

The first use of the precision level in the machine shop of which we have any knowledge was by Charles T. Porter in the early days of the Porter-Allen engine. That engine was the first to be made of a high grade of workmanship, and among the points to which Mr. Porter devoted especial attention was parallelism between the crank-pin and crank-shaft. To test his pins after they were in place, he fitted a precision level to a V-block of suitable size to straddle the crank-pin. By applying this instrument to the crank-pin at the two centers the parallelism in one direction could be tested, and by repeating the operation with the pin on the quarters the parallelism in the right-hand direction was also tested. This was certainly a suitable, as it was at that time an entirely novel, application of an instrument which was then a stranger in the machine shop.

## Herman Esser

Herman Esser, formerly of the Keuffel & Esser Company, died at Godesberg on the Rhine, Germany, on April 16, at the age of 62.

Mr. Esser was born in Dueren, Germany, and emigrated to this country when a young man, where he formed a partnership with Mr. Keuffel in 1867 under the firm name of Keuffel & Esser, for the sale of drafting instruments and other things of a similar nature. Later they took up the manufacture of these instruments and the firm finally grew into a stock company for the manufacture and sale of drawing materials and surveying instruments.

Mr. Esser was vice-president and treasurer of the company until 1902, when he retired from active business and moved his family to Godesberg on the Rhine, to enjoy the fruits of his labors. He was a member of the Hardware Club.

Some patents were held by Mr. Esser for improvements made in some of the instruments which were manufactured by the company and the business was built up to its present size from a very small beginning by the active labors and business management of himself and partner during the 35 years that he was connected with it.

Mr. Esser had an attack of pneumonia and went to the southern part of Germany to obtain relief. Thinking he was recovered, he returned to his home apparently as well as ever but the disease again showed itself and in less than five days he passed away.

## New Publications

GAGES AND GAGING SYSTEMS. By Joseph V. Woodworth. 249 6x9-inch pages and 258 illustrations. Hill Publishing Company, New York. Price, $2 net.

This volume is a most useful compilation of articles taken from technical publications, largely from the AMERICAN MACHINIST, dealing with gages and gaging methods used in machine shops. It illustrates and describes the construction, use and application of many types of gages for making interchangeable parts and precision tools, and for inspecting and testing machinery, parts and tools.

Thus it reaches the manufacturer, inspector and toolmaker. It is divided into eight sections which treat of, Gage Making, Inspecting Gages, Measuring Machines and Special Indicators, Lathe, Planer, Surface and Universal Gages and Indicators, Thread, Worm, Gear Tooth, Depth and Miscellaneous Test Tools; Inside Micrometer Calipers and Gages for Internal Measuring; Hight and Vernier Gages and Attachments; Squares, Straight-edges, Test Blocks, etc.; and, Outside Micrometer Calipers and Their Attachments. The work is of value as it shows the best practice of foremost machine shops in regard to gaging methods and systems.

The Koreans, having discovered the service and comfort afforded by electrical power and lighting, are rapidly installing small motors in their shops and lights in their homes.

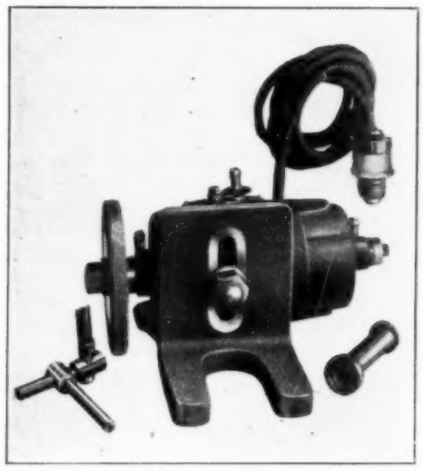
# New Tools and Machine Shop Appliances

**Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost**

## THE LATEST INFORMATION

### Electric Center Grinder

This has been designed for those who desire a more rigid construction than is possible when the grinder is mounted on a shank of the same size as the lathe tool. In this case an angle-plate has been substituted for the shank and this plate straddles the tool post and is held under it so

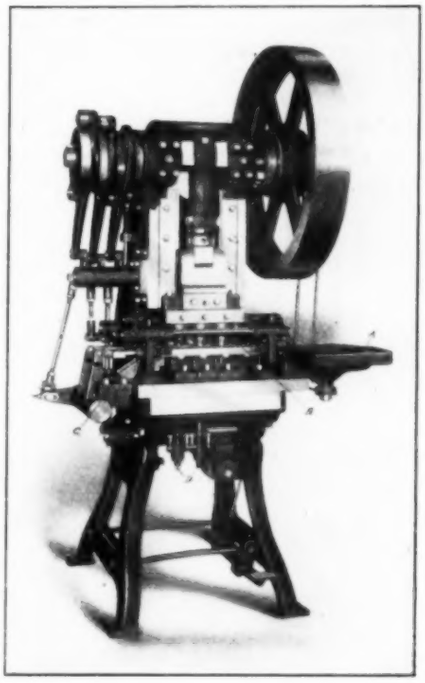


ELECTRIC CENTER GRINDER

as to be rigidly clamped by the tool. The whole driving head is adjustable at any angle and also for hight by means of the slot in the angle-plate. The bearings are dust-proof and adjustable for wear, and the motor is of the air-cooled type. The manufacturer is the United States Electrical Tool Company, Cincinnati, O.

### An Automatic Gang Press

The half-tone shows a new special automatic press designed and built for performing at each stroke simultaneously, the second, third and fourth operations on shells on which the first operation of cutting and forming, or partly forming, has previously been done in another press. This type of press is especially adapted for a wide range of small articles made from sheet brass, tin, copper and aluminum. The operation of the machine is entirely automatic, the drawn shells on which the die operations are to be performed are laid on the revolving friction dial *A* right side up. This continually revolving dial is driven by a belt from a groove cut in the hub of the fly-wheel and carries the shells up to a stop from which they are automatically released one at a time, and gripped by the lateral feed *B* which places the shells in position under the first-operation die, after which operation it carries the shell from this through the subsequent operations, finally discharging it into the chute *C*, from which it falls into a receptacle conveniently placed to receive the finished article. After the first three revolutions a finished blank is produced at each revolution of the press. The lateral feed is operated by means of cams on the end of the crank-shaft through the medium of connecting levers and cranks shown on the side of the press. The positive knockouts *D* for the dies are operated in the same manner. The main slide is adjustable allowing the use of dies as well as allowing for wear. The lateral feed is in every way adjustable. An important feature not to be overlooked is the fact that at no time is it necessary for the operator to have his hands near the dies, thus doing away with



AN AUTOMATIC GANG PRESS

all possible danger of accident to the operator.

The press runs at the rate of 75 to 100 strokes per minute, this depending on the size and shape of the shell on which the operations are to be done, performing from 225 to 300 operations per minute, entirely eliminating the intermediate handling between operations, saving much time, labor and shop room.

This press is built by the E. W. Bliss Company, 1 Adams street, Brooklyn, N. Y.

### Motor-driven Sensitive Drill

The accompanying illustration shows the application of an electric motor to the variable-speed drill press manufactured

MOTOR-DRIVEN SENSITIVE DRILL

by the Washburn Shops of the Worcester Polytechnic Institute, the belt-driven type having been shown on page 549.

The motor is bolted to the rear of the column just high enough to clear the square table when this is swung aside to use the round table, crotch, or cup centers. It also permits the chips being brushed from the table without damage to the motor, and the speed variations being mechanical, permits the use of a constant-speed motor.

The motor runs at 1200 revolutions per minute, and by means of a double-disk friction a speed variation of the spindle is obtained ranging from 400 to 1600 revolutions per minute. The drill spindle is stopped, without stopping the motor, by throwing the speed lever to its extreme position. When in this position, the driver disk is out of contact with the rolls, the disk being recessed for this purpose. When in this position the weight of the rotor is carried by a collar. When the roll is in contact with the disk, the spindle is raised slightly and the weight of the rotor is taken by the disk. On starting

the motor, the roll is out of contact with the driver disk and the motor starts without load. When the load is thrown into contact with the disk, little power is required to run the machine, as the normal pressure on the roll is very slight until the drill is in use and then the pressure increases or decreases as the work demands. The induction motors which are furnished as a regular equipment with the machine are 110 or 220 volts, two or three phase, 25, 40, or 60 cycles.

## Boring, Reaming and Tapping Machine

This is a special machine for use in making hot-water heaters and similar work. The sections shown have three holes, one at the top and one in each leg, which must be bored and reamed to receive a taper bushing, and have to be a nice job so that all three holes can be drawn up together and all be tight. This operation is shown in Fig. 2, where the sections are laid on the round table with the holes equidistant from the center, so that as soon as one is bored the table can be swung to bring the next one into place. After a lot are bored, centering bushings are placed in the table at the proper points to guide the reamers and insure proper location.

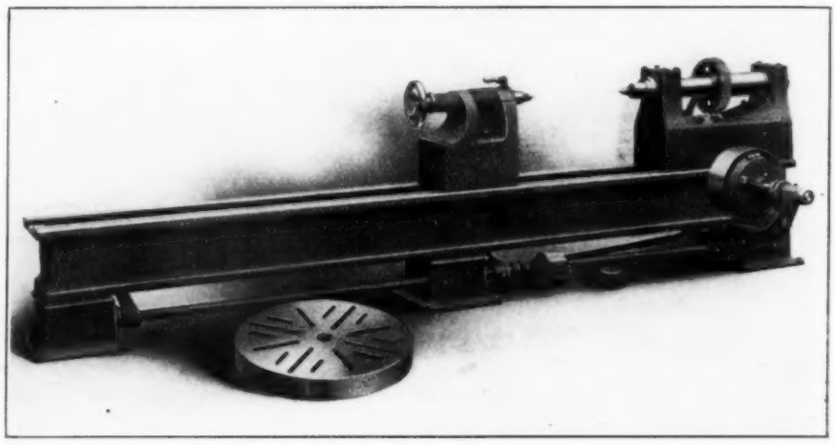
To enable the holes in the top of the section to be bored and tapped, the round table and the upper flat table are removed and the piece stood on end, as in Fig. 1, in the space which is 40 by 56 inches. This can be covered by the flat table alone or with the addition of round tables of any size desired. The table shown in Fig. 2 is mounted on ball bearings and turns very easily.

The machine is built in two sizes and either may be belt- or motor-driven, as desired. In the machine shown the variable-speed motor is belted to the pulley above and will carry an 8-inch pipe tap, while the larger size will carry a 10-inch tap. The small machine uses 5 horsepower, speeds of 4 to 1 by motor and 4 to 1 by back gear and 20 feed changes. The large machine takes 7½ horse-power and 6 speeds. Both occupy 11x5½ feet floor space. They are built by Baker Brothers, Toledo, O.

## Armature-banding and Field-coil Winding Lathe

This has been designed especially for manufacture of electrical machinery and electrical repair shops, for the rapid and economical winding of armature bands and field coils. The driving mechanism is through a friction clutch and a pair of spiral disks which run in oil and which with the four sets of change gears furnished, give spindle speeds of 15, 30, 60 and 120 revolutions per minute.

The clutch is operated by a pedal which runs the entire length of the bed, but which is concealed from view in the illustration, and this enables the operator



LATHE FOR WINDING ARMATURE BANDS

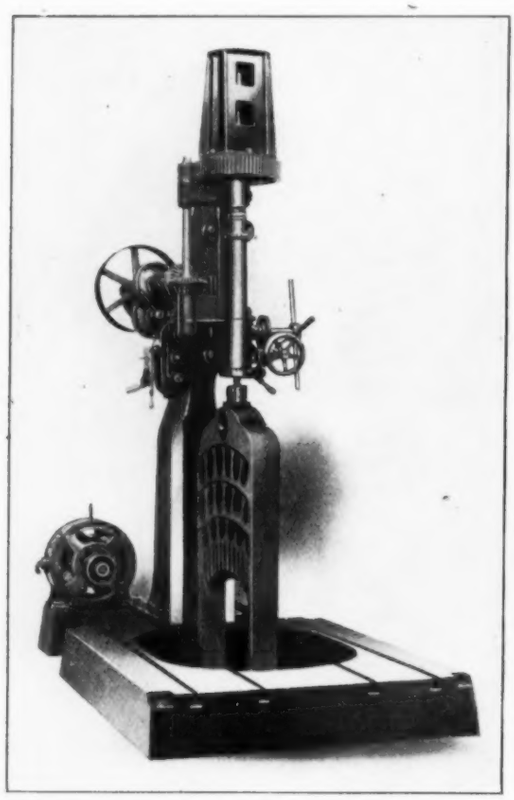


FIG. 1. TAPPING THE TOP OF A CYLINDER

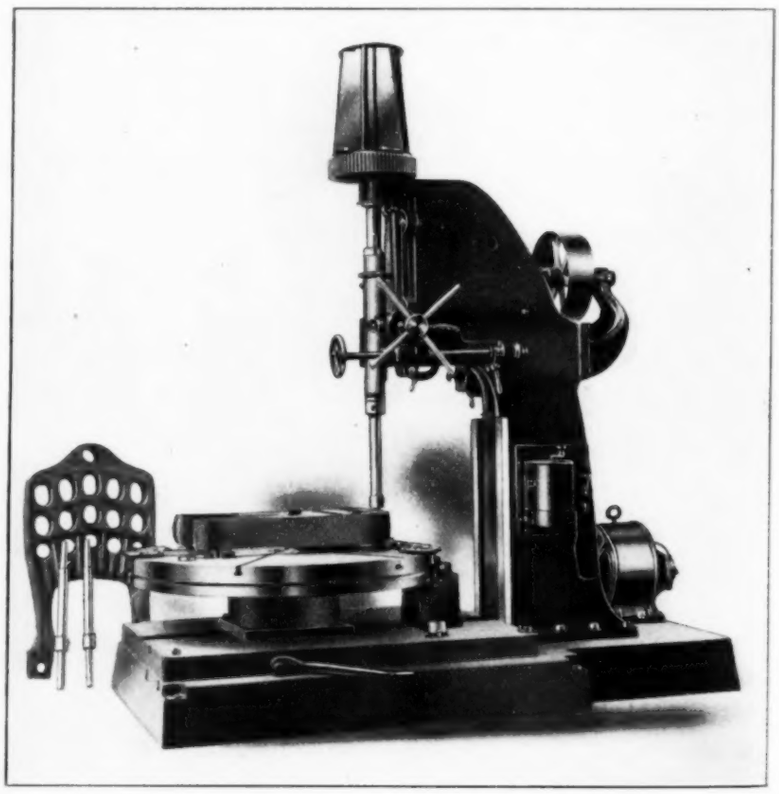


FIG. 2. BORING AND REAMING SIDE HOLES

to start and stop the machine instantly from any point along the bed.

The lathe centers are 36 inches from the floor so as to make it convenient when working on armatures of large diameter. The bed usually furnished is 12 feet long and will accommodate 8 feet between centers. Longer or shorter beds are supplied when required. They also furnish a special long traveling slide rest so that commutators can be turned while the armature is in the lathe. When a motor drive is desired a gear is substituted for the pulley and a heavy bracket supplied in place of the one shown on which the motor is mounted. It is manufactured by Greaves, Klusman & Co., Cincinnati, Ohio.

## Flexible Metallic Belt Coupling

In this belt coupling the aim has been to combine strength and simplicity with the flexibility of the leather belt lacing

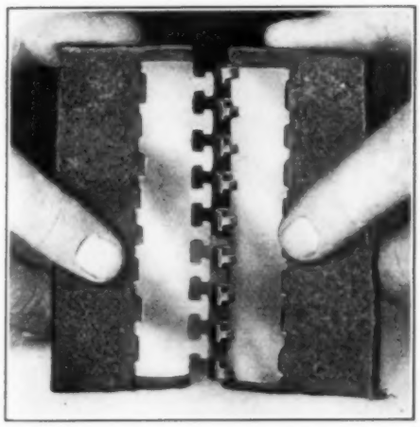


FIG. 1. FLEXIBLE METALLIC BELT COUPLING

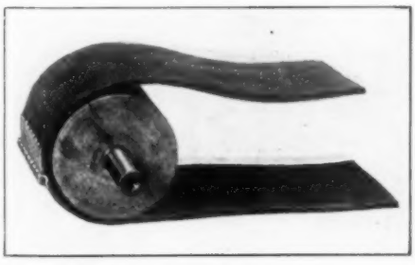


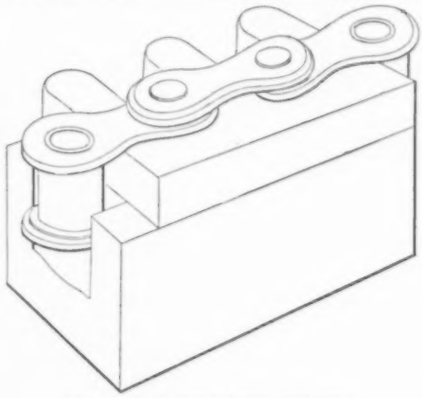
FIG. 2. BENDING OVER A SMALL PULLEY

and to secure this, the hinge joint shown has been designed and made practical. Fig. 1 shows two ends of a belt ready to be hooked together and it can readily be seen that such a joint would hug a pulley much closer than a joint of solid metal. Fig. 2 proves the case very conclusively.

To apply, the belt is squared, a line drawn equal to half the width of the coupling, the teeth or prongs driven into the belt and clinched and the joint is ready to put together. It has the further advantage of being easily taken apart and replaced should occasion require. It is made by the Tostevin & Cottie Manufacturing Company, 635 Kent avenue, Brooklyn, N. Y.

## Chain Repair Block

Now that chains are coming to be used so extensively in machine-tool construction for feed drives and similar purposes,



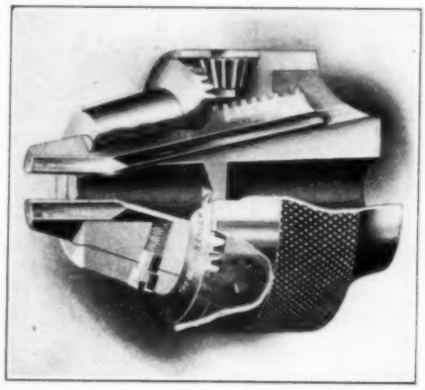
BLOCK FOR REPAIRING CHAINS

it is quite essential to have some way of repairing them, should anything happen to get them out of order. Sometimes a link is defective or becomes injured, and it is for such cases that the repair block shown herewith has been provided. The chain is placed in the block as shown, which holds it so that the rivets are easily removed and the side bar taken off to be replaced by a new one when necessary.

These blocks are small enough to go in the pocket, and as can readily be seen, they help to make chain repair easy. They are made by the Diamond Chain and Manufacturing Company, Indianapolis, Indiana.

## New Model Geared Drill Chuck

This is a new model of the drill chuck having inclosed gearing, made by the



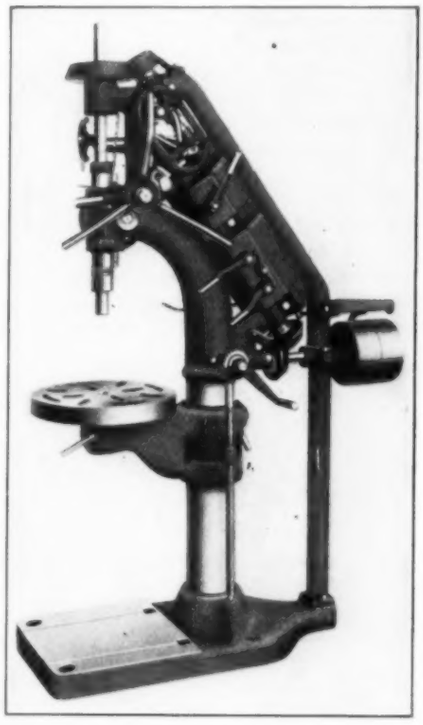
NEW MODEL GEARED DRILL CHUCK

Skinner Chuck Company, New Britain, Conn., in which they have added a second pinion to give two opportunities for applying the wrench to every revolution, and also to add to the life of the pinions. It is, of course, still possible to operate the chuck by hand as in the old model, the wrench being used for the final tightening or in loosening a drill.

The jaw has a long bearing in the solid threaded nut, which tends to maintain the original accuracy of the chuck. This, it is claimed, is within 0.002 inch, or the chuck is rejected by the inspector. The chuck presents a smooth surface to the workman and is easily taken apart to clean and oil without any tools but a screw driver.

## An All-geared Drill Press

The engraving shows a drill press of unusual design and one which has several novel features. All the gearing is in the cases over the arch of the column and all is controlled by the handles within easy reach of the operator. The ties between the column and the back brace make a rigid construction. The spindle is double splined, has large ball-thrust bearings. The speed changes are controlled



AN ALL-GEARED DRILL PRESS

by the two levers on the lower gear box which give four changes of speed without the back gears. These are in the upper box and double the number of speed changes which are so proportioned as to handle anything from ¼-inch to 2-inch drills.

Feeds are positive and controlled by the small lever near the top of the spindle, which gives variations from 0.001 to 0.025 inch for every revolution of the drill. These can be changed without stopping the machine and is a very convenient feature. There is also an automatic stop for drilling holes to any desired depth. The hand-feed is by the three-spoked pilot

wheel which operates through the internal gear on the other side of column to move the spindle sleeve. This is thrown in and out of mesh by the handle shown and makes a handy quick return without an additional handle.

When tapping is desired, friction-reversing pulleys are put in place of the tight and loose which gives a geared tapping machine without any attachment. It can be motor driven very easily, and it is so equipped when desired. This drill is built by the Barnes Drill Company, Rockford, Ill.

## Automatic Spur-gear Cutter

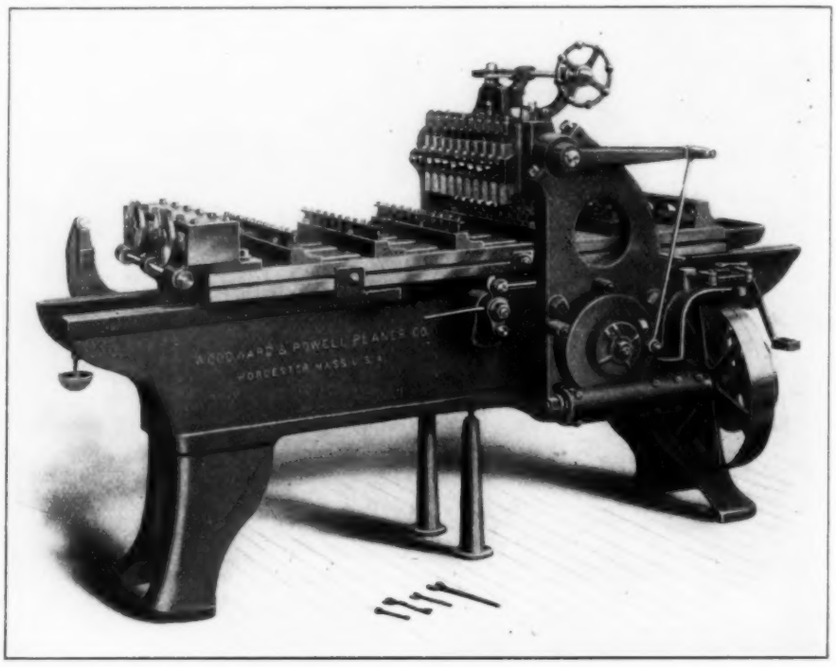
There are many shops using spur gears which have no occasion to cut bevels and to meet this trade the Eberhardt Brothers Machine Company, Newark, N. J., has brought out the small automatic spur-gear cutter shown. This will handle anything up to 28 inches and from 20 to 6 diametral pitch in cast iron, 8 pitch being about the practical limit in steel. In their own shop one of these machines is kept busy on change gears and similar work.

The overhanging arm is removed on work over 17 inches but is used in most other cases, the cutter pressure being taken by the rim rest whenever necessary. The work arbor has a taper shank fitting the hole in the spindle and a bolt is provided at the rear for drawing in and forcing out the arbors without hammering. For work held on a mandrel or for a solid pinion, a pair of centers are furnished.

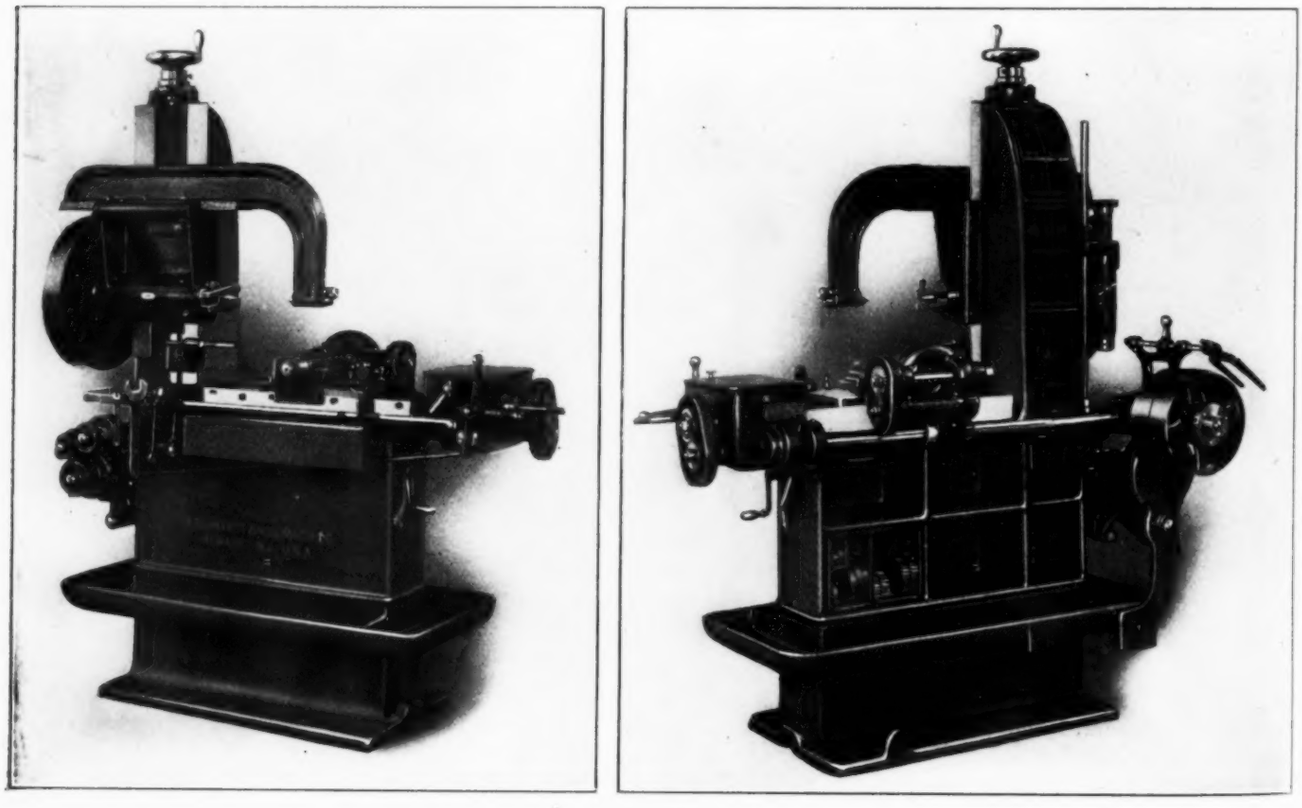
The cutter drive is shown very clearly in Fig. 2, while Fig. 1 shows the feed and the indexing gearing as well as the general construction of the machine. It has been designed so as to be easily set up for odd jobs as well as for regular work and as it is entirely automatic it makes a valuable tool for manufacturing purposes as it cuts an 8-inch face and swings 17 inches under the arm or 28 inches without it, although the nominal rating is 24 inches.

## A Fluting Planer

This is designed to plane the grooves in feed rolls for textile machines, these rolls being about 1¼ inches in diameter. There are 10 centers on the planer table to accommodate 10 rolls side by side, and where the length of rolls will permit, two rows in length, making 20 rolls on the planer table at one time. As the rolls are




PLANER FOR FLUTING TEXTILE ROLLS



TWO VIEWS OF AUTOMATIC SPUR-GEAR CUTTER

usually made with a square tenon at one end and square mortise at the other, the centers at the front end of the table are square, and fit into the mortise end of the roll, and are placed in two groups. The center spindle of each group has a dial on the outer end, five spindles being geared together. These dials are left blank so that the required number of notches may be cut to suit the number of grooves required in the feed roll. The hole in these dials is placed a little out of the center, so that the space between the notches will not be the same. This prevents the forming of teeth in the leather roll against which it runs.

Two pawls on the horizontal shaft that runs crosswise of the front end of the table engage in the notches of the dial, and when the table is running back, each spindle is turned ready to cut the next groove. When the table starts on the cut, a spring forces the shaft back to its original position.

When the table starts to return quickly, the lever which is connected to the end of the trunnion is pulled down by the friction on the side of the bed at the base of the housing. The 10 cutting tools are raised clear from the rolls when the table is returning by a friction operating through the long lever, and as soon as the table is reversed, these tools drop into place ready for the next cut. Each toolholder can be vertically adjusted by a screw and the entire head can also be adjusted vertically by the hand wheel and worm on the top of the crosshead. This is made by the Woodward & Powell Planer Company, Worcester, Mass.

## A Horizontal Attachment for a Vertical Miller

The advent of the vertical milling machine was followed by the vertical-spindle attachment for the horizontal type of machine. Now in turn follows a horizontal attachment for a vertical miller. As designed by the Becker-Brainard Milling Machine Company, Hyde Park, Mass., and illustrated herewith, this attachment bolts to the lower end of the sliding hood concentric with the spindle.

The attachment shown in Fig. 1 consists essentially of two parts, the upper which is stationary, and the lower which may be revolved in a horizontal plane beneath the upper. Graduations upon the surface of the latter permit of accurate adjustment of horizontal spindle to any angle; T-headed bolts in T-slots lock it in place. The horizontal spindle, supported at both ends, carries a bevel gear which is driven by a corresponding gear with taper shank inserted in the vertical spindle. End play on the horizontal spindle is taken up at one end by nut and checknut, while at the other end provision is made for securing a cutter, either by key and clamping nut or by insertion of taper shank in the end of the spindle.

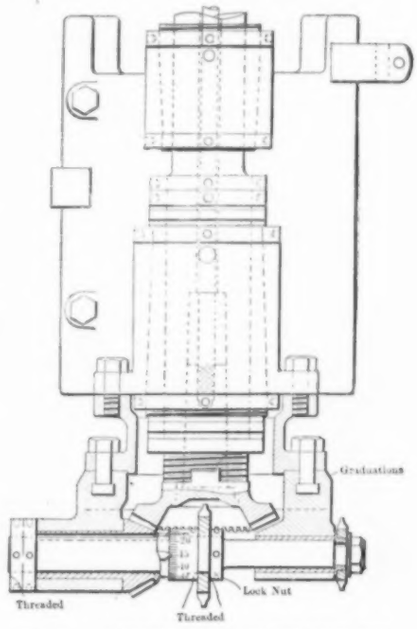



FIG. 1. HORIZONTAL ATTACHMENT FOR VERTICAL MILLER

At the intersection of the center lines of the horizontal and vertical spindles may also be inserted a cutter for general use, but specifically for cutting spirals. This is held between two nuts, one of which is graduated so that adjustment having once been made for any given thickness of cutter, it may be duplicated for the same cutter. This attachment materially increases the scope of the vertical miller. It gives it the same range as the horizontal type in the cutting of worm and spur gears, spirals, hobs and racks, while it retains other characteristics peculiarly its own.

A practical application of the horizontal attachment of slightly different construction is shown in Fig. 2 in connection with a No. 6 Becker-Brainard vertical miller. Here it is utilized for cutting the axial buckets in a Sturtevant steam-turbine disk. This disk is mounted upon and clamped to a circular slotted-edge jig plate which revolves freely about a pin projecting from a circular base plate which is securely clamped to the platen. The diameter of the pin is the same as that of the turbine shaft; the slots in the jig plate correspond in number and spacing to the buckets to be milled in the disk. A spring pawl or pin holds the ring in place as each bucket is being milled. The vertical type of machine presents the advantage of great distance between

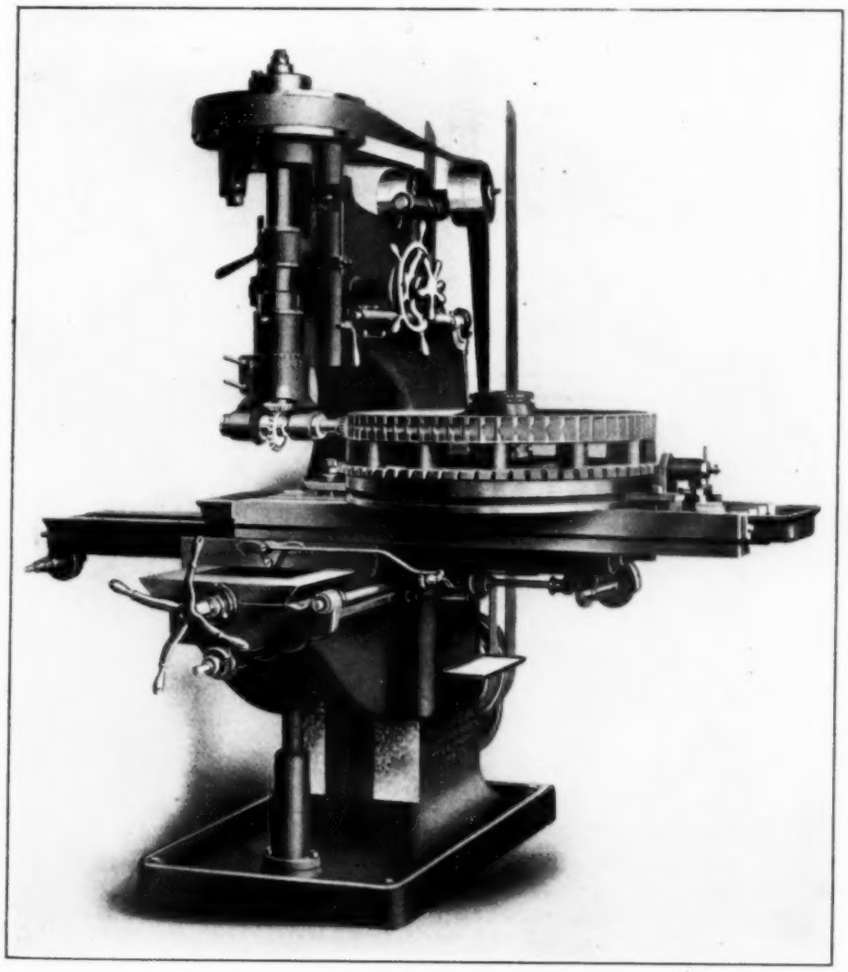


FIG. 2. MILLING A TURBINE BUCKET

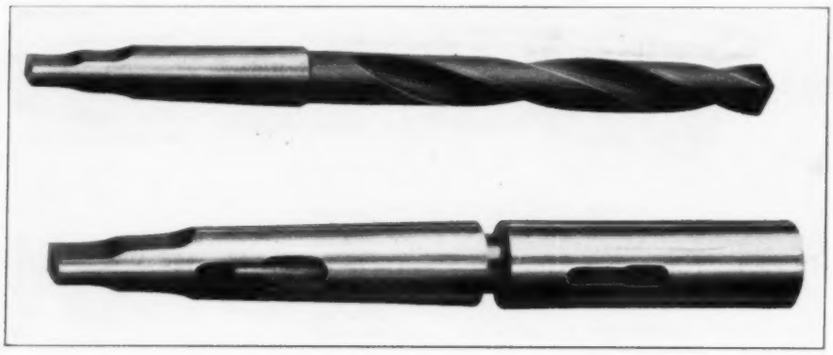
the neck and the center of vertical spindle which in this case gives ample room for the disk which is 26 inches in diameter.

## A Double-tang Drill Drive

The latest development of the drill-driving problem is shown in the new drills and sockets of the Cleveland Twist Drill Company, Cleveland, O., known as the "Perfect" double-tang socket. This involves a second tang below the regular one, which gives an additional drive and is especially handy for using drills that have the regular tang broken off, as these can have a new one ground or milled on the remaining shank to fit the socket.

The new tang is 60 per cent. thicker than the old one, and is much stronger, so that old drills have their life renewed to last as long as the cutting end. This renewal is done in the simplest way possible, either grinding or milling, and is much cheaper in every way than milling key-ways or providing similar methods of driving. As a means of using up old drills with broken tangs, even if for no other reason it will appeal to many shop managers, and as there is no advance in price from the regular socket, there can be no hesitation in trying them out.

This makes it possible to order new drills without the usual tang but with the large tang which is stronger in every way and also shorter by the length of the tang. This evolution can continue to the point where new sockets would have the large tang only and we have a new standard length of taper by a natural process.



A DOUBLE-TANG DRILL AND TWO DRILL SOCKETS

## Cincinnati Gear Cutter

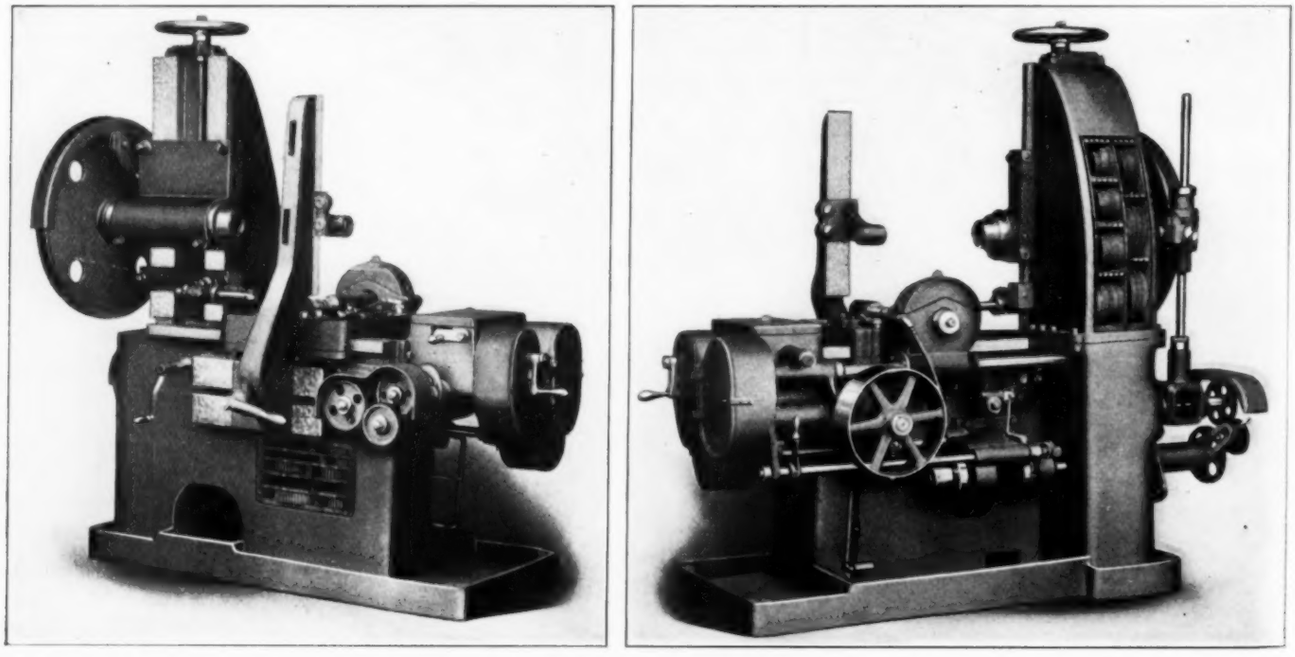
In designing this machine special attention has been paid to reducing the length of the bed and at the same time the driving shaft, so as to insure rigidity, reduce chatter of cutters and preserve accuracy. To this end shafts are made large, the guiding surfaces of both cutter carriage and work saddle have long and narrow bearings to avoid binding, and both are provided with full length adjustable taper gibs.

A general idea of the design can be obtained from Figs. 1 and 2, and by referring to Figs. 4 and 5 the details of operation are easily seen. This is a plan view in which *A* is the work head, *B* the cutter carriage, *C* the screw for feeding carriage, *D* the clutch which engages the screw with either the slow forward feed or the fast return feed, *E* the adjusting screws for the dogs, which limits the travel of the cutter carriage; *F F* the shafts which allow the adjustment of these dogs from the side of the machine, *G* the tappet or stop on cutter carriage, which engages with the dogs, and *H* is a hook located on the outer dog-adjusting screw and which releases or engages the indexing mechanism after the cutter is returned to the starting point by the high-speed return movement of the carriage. This hook is also seen in Fig. 2.

### Cutter-carriage Control

The handle at the left in Fig. 2 is on one of the shafts *F*, which, as can be seen in Fig. 4, turns the dog-adjusting screw *E* by means of the spiral gears. There are two shafts *F* and two screws *E*, each of which controls a dog. One is threaded to each screw and passes over and is guided by the other screw. By turning either shaft *F* its dog is adjusted to the desired position.

When the carriage has moved through the cut the tappet *G* engages the forward dog and moves the screw *E* till the spool at the end of *E* throws the clutch lever enough to disengage the slow forward feed, and the inclined plunger at the end of this lever throws it to the left until it engages the high-speed return clutch driven by the gearing at the end of the machine. When the cutter is clear of the work the hook *H* shifts the indexing mechanism and allows the work to be



TWO VIEWS OF THE "CINCINNATI" GEAR CUTTER

moved one tooth space. The tappet is made so that in its normal condition it strikes the dog which controls the movement of the cutter carriage, but it is so arranged that the carriage can be run to the extreme position desired for any purpose without disturbing the setting of the dog for the work in hand.

The indexing mechanism is interlocked with the feed screw so that the cutter cannot enter the work until the indexing is completed. Referring to Fig. 5 it will be seen that line shaft *A* passes through the index worm and down to the box containing the miter gear, which connects it with the main drive of the machine. By loosening a nut on the side of the worm case and shown in Fig. 2 between this and the gear rack, the worm can be swung out of mesh with the indexing wheel and the stud *B* is so arranged that the proper engagement of the worm and the wheel are assured. When setting the work the screw *C* is loosened, which releases the friction on the blind rod and allows it to be turned by the milled disk above *C* so that the index wheel can be turned in any position.

### Interlocking the Indexing

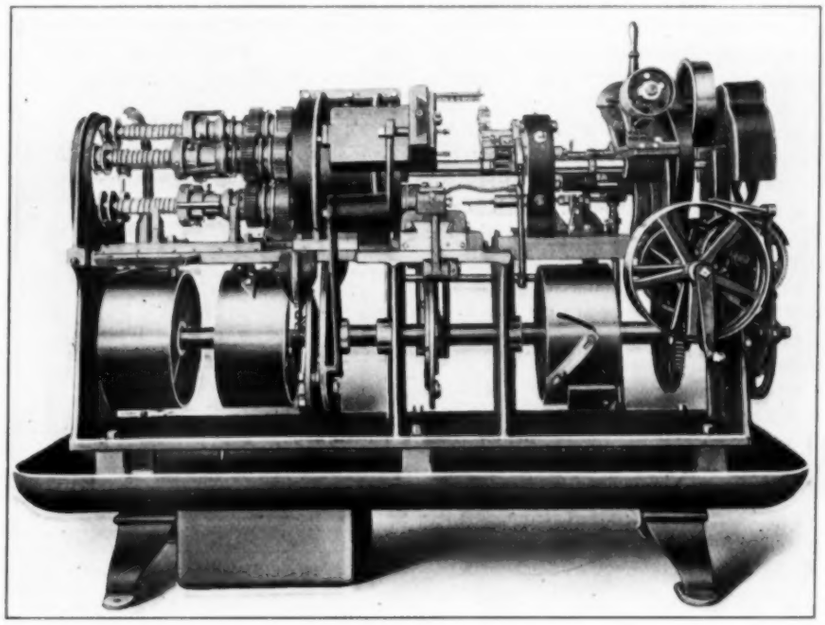
Fig. 3 shows the interlocking mechanism, which is located inside the same box as the clutch in Fig. 4. This interlocking is controlled by the arm *D*, which is connected with the spools of the clutch and comes down near the pin *E*, which is controlled by the arm F, also seen in Fig. 2, and which is connected with the indexing mechanism.

When the hook *H* engages the indexing trip it rotates the shaft on which lever *F* is mounted, and raises the pin *E* so as to lock the clutch spool and prevent the cutter carriage being fed into the work until the indexing is completed; after which arm *F* drops to its normal position, the rod *E* is forced down by the spring shown and the clutch is free to be thrown for the forward feed.

This machine has been carefully tried out by its builders, the Cincinnati Shaper Company, Cincinnati, Ohio, and has cut accurate gears of three pitch in cast iron at a maximum speed of 7¼ inches per minute from the solid, no previous stocking having been done. It is built in two sizes, one for 36, the other 48-inch gears with 10-inch face, and handles 3 pitch in cast iron, 4 in steel.

## Improvements in the Five-spindle Automatic Screw Machine

The five-spindle Spencer automatic screw machine, first shown on page 160, Vol. 29, Part 1, has been improved in several ways and the new machine is shown herewith. The first difference noted is in the head, and in place of the three driving belts there is now but one, which drives the spindles through the gears at the end of head and the camshaft by the short belt from the small pulley on the cross shaft. This cross shaft is provided with a clutch, controlled



THE NEW UNIVERSAL SCREW MACHINE

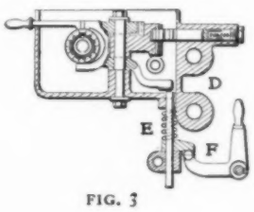



FIG. 3

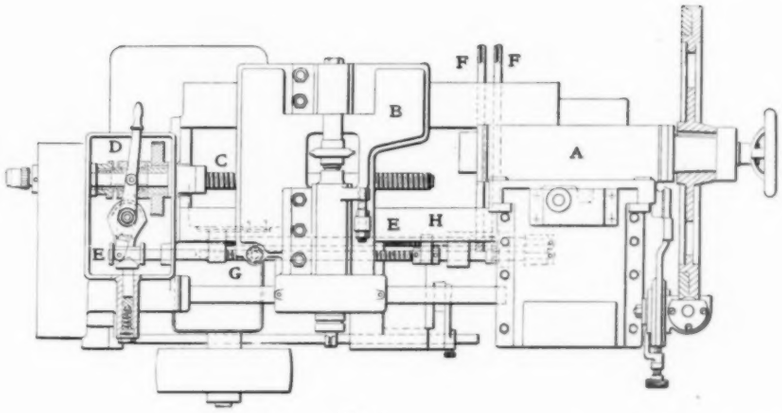



FIG. 4

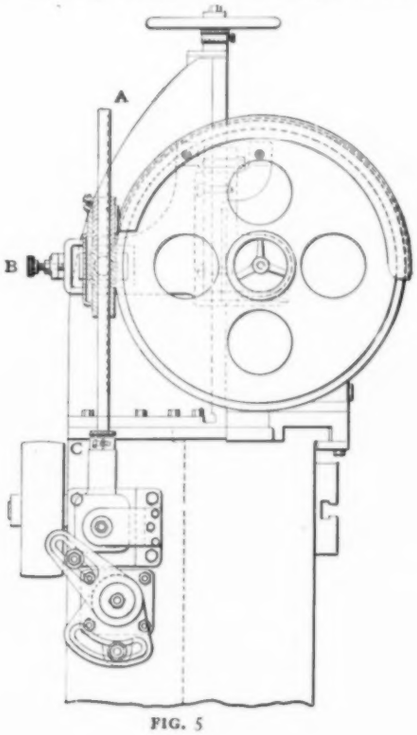



FIG. 5

DETAILS OF CINCINNATI GEAR CUTTER

by the lever shown, so that the feed can be thrown out while a brake stops the feed at once, preventing damage to tools or stock. It is also handy when setting up the machine, as it gives power feed which is under absolute control.

The gearing at the end of head allows any desired ratio of speeds between the threading and reverse when using taps or dies. And in place of the frictions between the forward and reverse gears at the end of the spindle, there is now a positive clutch for this purpose.

There has also been a change in the drive of the cam-shaft, which now has two pulleys on the worm-shaft instead of three. The ratchet has also been cut out and one pulley drives direct, while the other drives through the reducing gears shown, which can be changed to suit conditions. These changes are controlled by dogs on the cam-wheel or plate at the extreme right, which shifts the belt so as to change the speed of any operation desired.

The locking bolt for the turret has been changed from round to rectangular, tapered on the bottom and straight on top, with a bearing surface of from 2 to 3 square inches, according to the size of the machine. It is of tool steel, hardened and ground, and has a screw adjustment to take any wear. The oil pump is gear-driven to avoid slipping of belts, which get oil-soaked in this work and often give trouble. The oiling nozzles have been changed so as to give a flood either on the tools, from a pipe with jets at each tool, or from a magazine nozzle, which goes over the work. Either or both of these can be used at will. The machine is made by the Universal Machine Screw Company, Hartford, Conn.

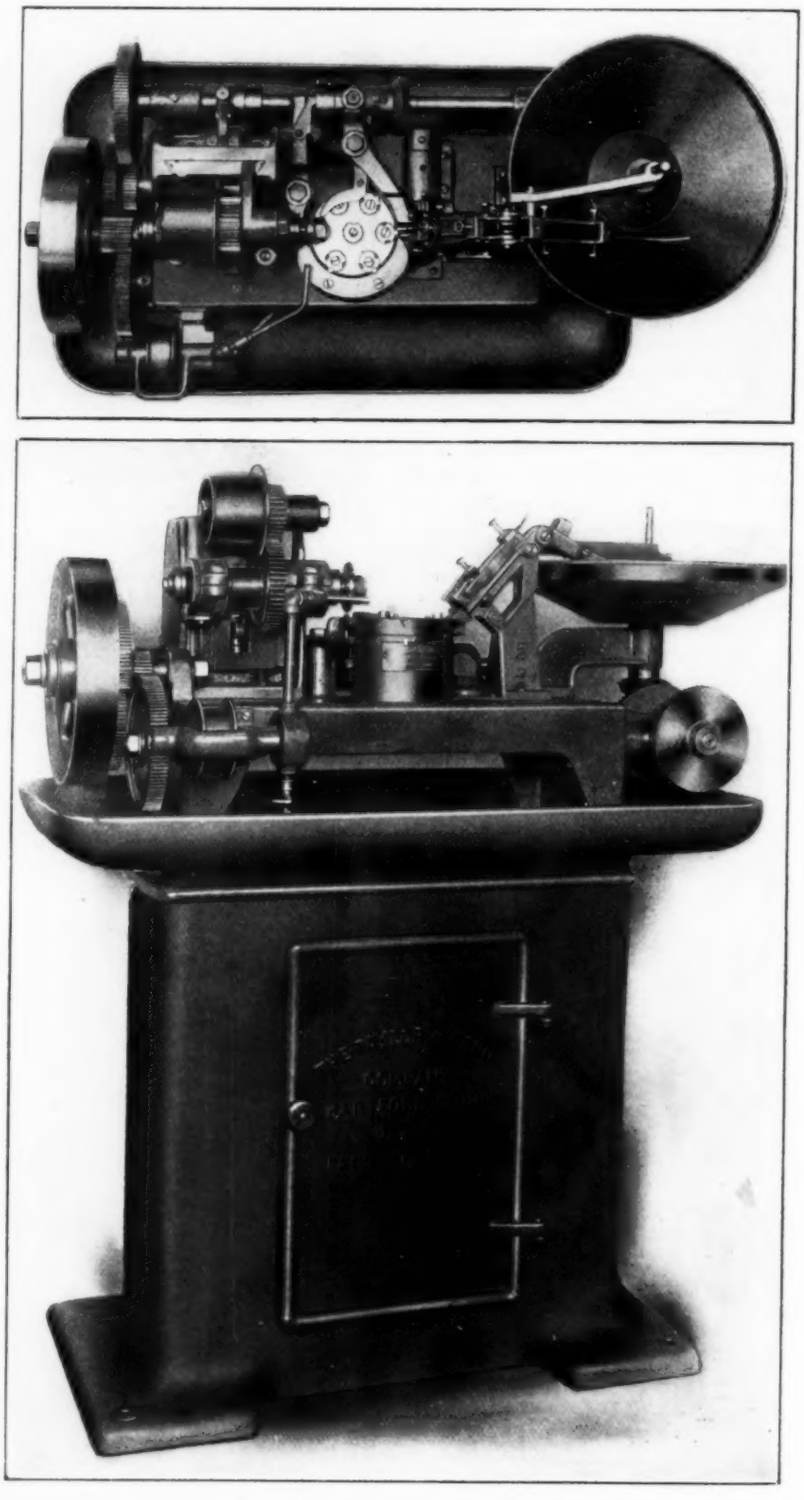
## Automatic Screw Slotter

This differs from other screw slotters in having the table horizontal and this has some advantages in simplifying the holding of the blanks, as gravity is always working in its favor.

The head carrying the slotting saw moves up and down in its dovetail slide under the control of a cam for the downward or working travel and after the head has been sawed to the proper depth, it is immediately returned by two stiff springs ready for the next blank. It will also be noticed that there is no belt-tightening device for this head, the idea being that as the vertical movement is comparatively small, and as the saw is doing no work in the upper position of the saw head, it is not necessary to have a belt tight at that point. As the saw head is set down into the work, it automatically tightens the belt and secures all the driving power required. The depth of the slot is determined by an adjustable shoe bearing on the cam face in the same way as the one shown on lever *G*. This makes a very simple and at the same time positive adjustment.

The cutter head is driven independently from the rest of the machine, as it has nothing to do with the indexing, and the speed of the saw in no way depends upon the rest of the machine, but only on its thickness and diameter. The rest of the machine, however, is driven from the pulley at the left, which is geared to the cam shaft so as to bring 16, 20, 24 or 28 screw blanks under the saw per minute, according to the size of the blank being slotted.

To provide against any possible damages to the machine, in case a wrong size blank should find its way under the saw, or if anything should stick, the main drive is by a friction device in the hub of the driving pulley, as can be seen at the left of Fig. 3. This can be set to slip at any



TOP AND FRONT VIEW OF AUTOMATIC SCREW SLOTTER

desired pressure, and is a safety valve against accident.

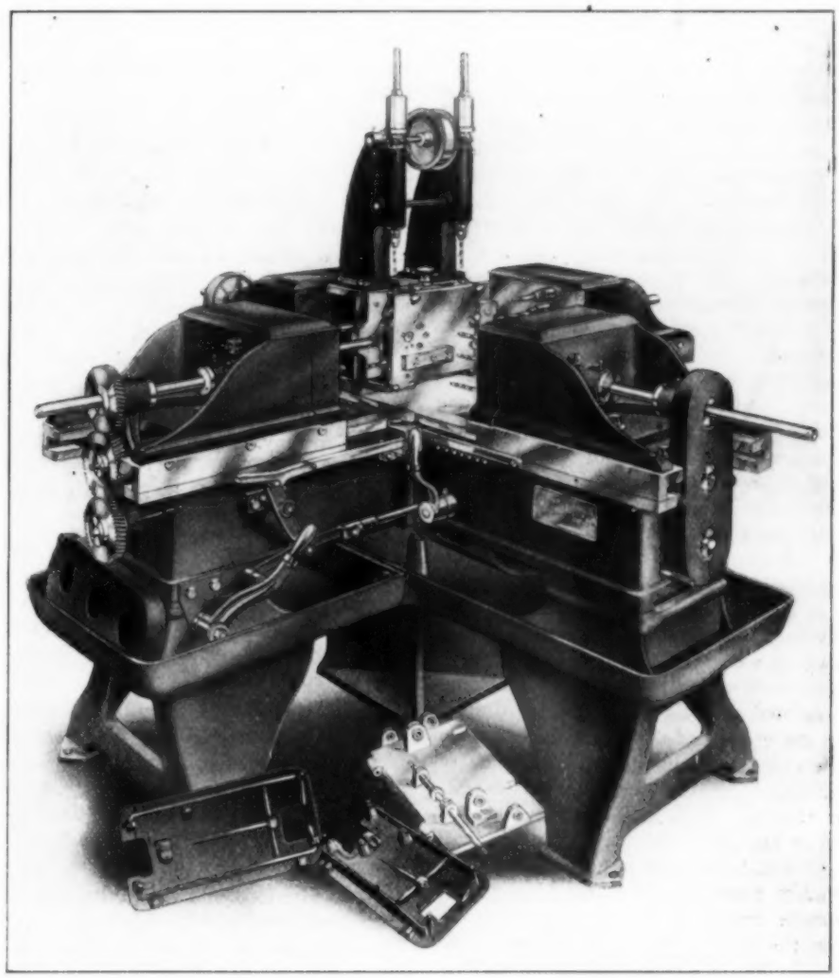
Cam *D* controls the arm *F*, which in turn moves the spring which holds the screw blank *F* into its slot in the revolving table until it passes behind the guard *H*. At the same time the screw shown in the end of arm *F* operates the cut-off which is in the end of the magazine slide and allows one screw blank to drop at the proper time. As the indexing plate revolves, it carries the blank loosely behind the guard *H* until they reach the working position under the saw. At this point the cam *E* operates lever *G* and holds the screw blank firmly against its die while the slotting saw is in operation.

Fig. 3 shows the indexing and locking mechanism, and in common with all the rest, this is driven from the cam shaft at the back. The bevel gears at the back transmit the power through the short shaft at right angles to it, and down through a vertical shaft by the second set of bevel gears. The lower end of this shaft carries the arm or finger *A*, which revolves once for every turn of the cam shaft. In the position shown it has been in contact with the escapement arm *B* long enough to force the lock *C* out of the rectangular slot shown in dotted lines below the sixth-tooth star or index wheel, and is just engaging one of the six teeth. As it continues its motion, it carries this tooth and with it the indexing head above just one-sixth of a turn. This is governed by the escapement arm *B* for, as soon as *A* passes out of contact with *B*, the spring forces the latch *C* down on the periphery of the locking disk and as soon as the next notch comes under *C*, it drops into place and holds the screw while it is being sawed. In the meantime the arm *A* has passed out of contact with the indexing tooth, allowing the final indexing to be determined by the latch *C*.

This is made by the Taylor & Fenn Company, Hartford, Conn.

## Multiple-head Drilling Machine

This is one of a series of machines built by the National Automatic Tool Company, Dayton, Ohio, and in this case the drills work from five different directions, from all four sides and from the top. In this particular case, it is at work on a sewing-machine bed plate, which contains 19 holes, one of them being ⅜ of an inch in diameter and 1 inch long and in addition to this five of them are counterbored, yet this whole drilling operation only required 45 seconds. The



UNIVERSAL DRILLING MACHINE WITH FIVE HEADS

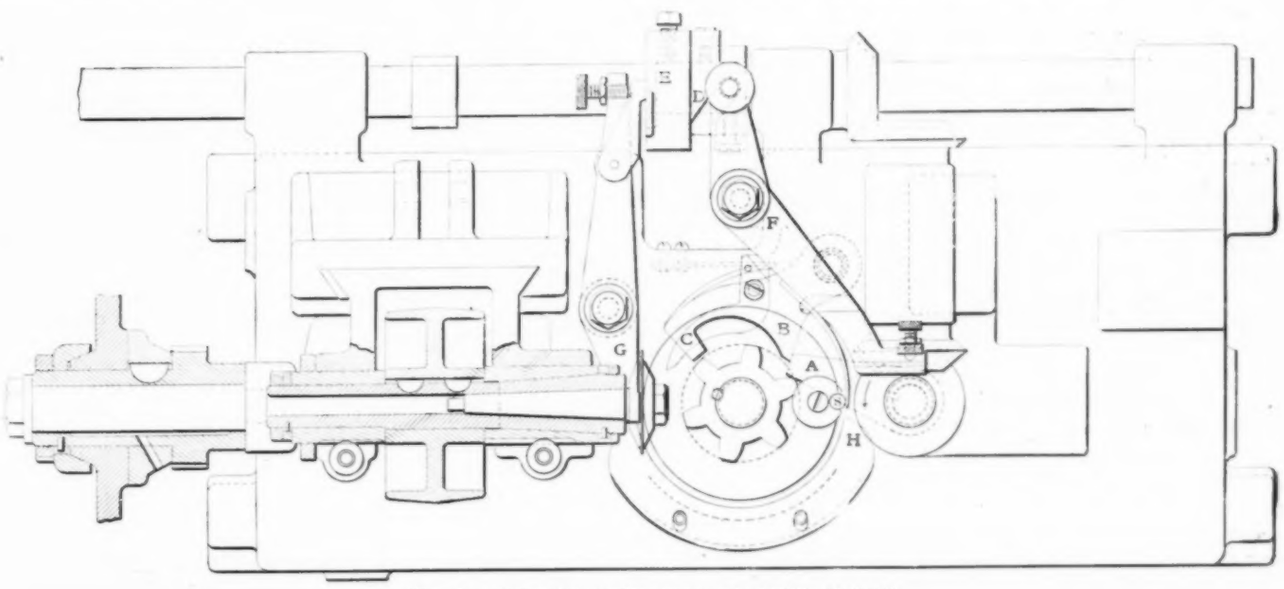



FIG. 3. INDEXING MECHANISM OF SCREW SLOTTER

machine is universal and automatic and can be arranged for a great variety of work of this kind. Rigidity has been kept in view and the bed is well ribbed so as to prevent deflection so far as possible, which adds to the accuracy of the alinement that can be obtained. The main drive shaft bears in a sleeve rigidly fastened to the bed and on this the cam drum revolves in one direction only. There is an endless track on the cam-drum which is laid out to secure a fast forward movement up to the work, a slower movement at the proper speed for the drill feeds and after the drilling, a rapid return.

Each head has a drill box which is securely fastened to it, each box is composed of two sections securely fastened together and both are made to hold oil for lubricating the spindles as well as the spindle and idler gears. Each spindle has three bearings and its drive gear is located between two of them. Where long life and absolute alinement are desired, the spindles are made of tool steel, hardened and ground and these run in bushings which are ground and lapped. In ordinary work, however, spindles are ground in the same way, but the bearings are made of phosphor bronze. In all cases they are provided with a ball thrust bearing and a lock nut on the back end to take up wear and end motion. All idler gear studs are hardened and ground and supported at both ends, the gear running on the middle of the chuck instead of on one end as is usually the case. Each removable drill-box carries a master gear so that the whole drill-box may be taken off by taking out the spindle driving shaft, and drill-boxes for other work can be readily placed on the machine. Each spindle carries a chuck made especially for the size of drills to be used. All chucks are fitted with the Morse taper.

These machines are built with from 2 to 5 drill heads as required and with a rotating or plain table adapted to carry 1, 2 or 4 jigs. They can be arranged with change-feed mechanism so as to drill either hard or soft metals. Oil pans are provided as shown and there is a receptacle for oil or any lubricating compound. The power is delivered from the back of the machine and bevel gears of large proportions are used in distributing it to the various heads, while the shafts which run the spindles in these heads are driven by means of steel spiral gears with rawhide idlers. Two of the bed plates are shown on the floor, as well as one of the drilling jigs.

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The estimated value of electrical and auxiliary manufactures in the United States for 1908, according to the *Western Electrician*, amounts to $315,920,000. The record-breaking year of 1906 produced less than 10 per cent. above these figures, the slight decline being due to a little let up in construction work.

## Personal*

D. Halstead, Jr., of the Carver File Company, Philadelphia, Penn., sailed on April 18 for Europe, expecting to visit several countries there before returning.

L. R. Pomeroy, for a number of years with the General Electric Company, has accepted a position with the Safety Car Heating and Lighting Company, as assistant to the president.

Paul R. Brooks has recently assumed the general managership of the Machine Sales Company, Peabody, Mass. Mr. Brooks was formerly connected with the Otto Gas Engine Works.

A. J. Gardiner, Jr., who has been with the Fellows Gear Shaper Company for the past five years, has accepted a position as special representative with the Landis Tool Company, Waynesboro, Penn.

Arthur P. Hagan, who formerly acted as assistant superintendent of the Rail Joint Company, is now connected with the Safety Car Heating and Lighting Company, Jersey City, N. J., as assistant engineer.

J. P. Doan, vice-president and general manager of the American Tool Works Company, accompanied by Mrs. Doan and Miss Alter, sailed April 22 on the "Mauretania" for an extended trip to England and the continent of Europe.

R. B. Hart, until recently mechanical engineer with the Kennedy Valve Manufacturing Company, is at present acting as consulting engineer with the Gaylord and Eitapenc Company, of Scranton, Penn. Mr. Hart is looking after the power-plant and heating contracts.

O. A. Hanford and F. W. Barkley, recently engineers with the General Electric Company, on special and automatic and labor machinery, have opened up offices in the German Insurance building, Rochester, N. Y., where they will devote their time to the design of this kind of work.

Joseph V. Woodworth, known to our readers as author of many articles published in our columns, as well as several standard books on shop methods and processes, has become general manager of the Harwood Manufacturing Company, Brooklyn, N. Y. Mr. Woodworth's company is engaged in the manufacture of brass and copper goods reinforced with a cement lining.

## Obituary

Frank H. Chamberlin, president of the J. D. Smith Foundry Supply Company, Cleveland, Ohio, died April 10.

Herbert L. Heyl, former actuary and acting treasurer of the Franklin Institute, died on April 15. Mr. Heyl was long associated with the institute, having served as acting treasurer up to last December for 22 years.

G. W. Dietz, proprietor of the Dietz Machine Works, Fountain street, Philadelphia, died very recently. As a developer of machinery for special purposes his name stood well, and his death will be much regretted by those who knew him.

*Items for this column are solicited.

## Business Items

The New York office of General Electric Company has been moved from the Edison building, 44 Broad street, to the Cortlandt building, 30 Church street.

The Blanchard Machine Company, Cambridge, Mass., at a stockholders' meeting held March 30, voted to increase the capital stock of the company from $15,000 to $40,000, and the new stock was all purchased by the present stockholders. The company has purchased the buildings in which its plant is located.

## Trade Catalogs

Westcott Chuck Company, Oneida, N. Y. Catalog of lathe and drill chucks. Illustrated, 48 pages, 3½x5½ inches, paper.

Crescent Tool Company, Jamestown, N. Y. Pamphlet describing combination pliers. Illustrated, 12 pages, 3½x6 inches, paper.

Matthews Manufacturing Company, Worcester, Mass. Catalog of sheet metal stampings. Illustrated, 8 pages, 6x9 inches, paper.

Hyatt Roller Bearing Company, Newark, N. J. Catalog No. 31 giving stock sizes of Hyatt standard bushings. Illustrated, 124 pages, 6x9 inches, paper.

Diamond Machine Company, Providence, R. I. Catalog of American grinding attachments and center grinders. Illustrated, 20 pages, 6x9 inches, paper. Catalog of improved wet-tool grinders, belt and motor driven. Illustrated, 16 pages, 6x9 inches, paper.

## Manufacturers

The F. W. Graham Company, Racine, Wis., is erecting a pattern shop.

The Bemis Brothers Bag Company, St. Louis, Mo., will build a new $40,000 factory.

The McEwen (Tenn.) Planing Mills will rebuild plant recently destroyed by fire.

The Columbia Shear and Cutlery Company, Reading, Penn., will build an addition.

T. B. Simmons Gin Company, Frederick, Okla., will rebuild cotton gin recently burned.

The Rock Island Railroad has made arrangements to enlarge its repair shops at Pueblo, Colo.

The Atlanta (Ga.) Hosiery Mills recently destroyed by fire will be rebuilt. S. A. Magill, is president.

The Lawrenceville (Va.) Lumber and Box Company has been organized and site has been bought for a plant.

It is reported that the Woodstock Iron Works, Anniston, Ala., is planning to build a foundry addition to furnace.

The Delphos (Ohio) Manufacturing Company, making oil cans, dust pans, etc., is building an addition to its plant.

Fire destroyed the planing mill and lumber yard of Finley & Campbell, West Newton, Penn., causing a loss of $50,000.

The Model City Machine Works, Anniston, Ala., has awarded contract for the construction of machine shop and garage.

The Nashville (Tenn.) Spring and Mattress Company will build a new plant to replace the one recently destroyed by fire.

Fire destroyed the plant of the Wilbur Corporation, New Haven, Conn., makers of window and door screens, cabinets, etc.

The Central Foundry and Machine Company, Collinsville, Ala., will erect a building to be used for the manufacture of sadirons, grates, etc.

The new plant now being erected for the Cumberland (Md.) Steel Company for the manufacture of turned and ground shafting is nearly completed.

The Sharkey Manufacturing Company has been organized at West Allis, Wis., to manufacture a new acetylene generator. C. M. Sharkey, president.

The Victor Safe and Lock Company, Norwood, Ohio, is said to be considering improvements at its plant which will involve an expenditure of $500,000.

The Tandem Gas Engine Company, Houston, Texas., recently formed, will erect a building and install machinery at a cost of $10,000. J. B. Hicks, manager.

The Wandell Motor Plow Company, Oklahoma City, Okla., has been incorporated with $500,000 capital. Fred B. Owen, Oklahoma City, is one of the incorporators.

The Glacier Metal Company, 14 North Ninth street, Richmond, Va., will erect a plant in Manchester for the manufacture of metals for railroad, machine shop use, etc.

The Kennedy-Walker Land and Development Company, Kenbridge, Va., plans organization of a company with a capital stock of $50,000 to establish a woodworking plant.

Plans have been about completed for the erection of three new coke furnaces by the H. C. Frick Company, of Pittsburg, in the Connellsville region. About $4,000,000 will be expended.

The West Side Lumber and Door Company, Hagerstown. Md., has been incorporated with $75,000 capital stock to manufacture all kinds of building material. Solomon George and others incorporators.

The American Automatic Railway Switch Company, Birmingham, Ala., has been incorporated with $500,000 capital stock to manufacture railway switches, frogs, etc. Harold Shernwell, president.

The National Valve Company, Baltimore, Md., has been incorporated with $125,000 capital stock to manufacture valves and plumbing fixtures. Charles A. Parks, W. M. Cary, A. P. Smith, incorporators.

**The Small-Townsend Manufacturing Company, St. Louis, has been incorporated to manufacture and deal in machinery. Capital, $25,000. Incorporators, C. T. Small, H. S. Townsend, John F. McDermott.**

**The Koger Pea and Bean Thresher Company, Morristown, Tenn., has been organized to manufacture a pea and bean thresher. Capital $50,000. J. J. S. Reed, president, and J. J. Koger, general manager.**

The **Columbia Bridge Company**, succeeding P. S. **Easterday & Company**, formerly of Fairbury, **Neb., has transferred its headquarters to Walla Walla, Wash., where a plant will be erected. Offices are in the Jaycox building.**

The plans made last year for improving the Pennsylvania shops and yards at Conway, on the Fort Wayne division, will be carried out this year. They involve the expenditure of $500,000 in the erection of buildings and the enlargement of the yards.

# Want Advertisements

***Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.***

## Miscellaneous Wants

Caliper list free.E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Engineering firm wants representation for reliable manufacturers. Address P. O. Box 1434, Pittsburg, Pa.

Model making. Patented machines manufactured on royalty. Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Drawings—Mechanical and structural designs furnished; new ideas developed to practical results. W. Brasack & Co., Pittsburg, Pa.

Wanted—Machinist with good ideas to take an interest in fine tool business. Good opportunity to progressive man. E. G. Smith Co., Columbia, Pa.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia.

Wanted—Shaper, about 20" stroke. Vertical power feed to head. Must be in good condition and a bargain. Box 29, AM. MACH.

Gears cut to order, bevel, spur and miter, on Bilgram and Gleason machines. Complete gears furnished. The Cincinnati Gear Works, Murdock Bldg., Cincinnati, Ohio.

A thorough mechanic wishes to buy an interest or outright, a small machine shop, which is so situated as to permit growth as developed; A-1 reference. Box 78, AM. M.

Machine shop in Sweden wants to take up the manufacture of good modern machines; would also undertake sales and commercial management in Sweden or Norwegen. Box 87, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Machinists take notice. Purchase castings and blue prints of high grade gasolene motor, of world-wide reputation and at a profitable business. Write today. F. P. Conrad, 242 Freeport St., Harrison Sq., Boston.

British patent rules, 1908. We can produce light fine engineering and mechanical specialties and tools, accuracy and finish guaranteed. Model Manufacturing Co., 52 Addison Road, North, Holland Park, London.

## Situations Wanted

*Classification indicates present address of advertiser, nothing else.*

CANADA

Draftsman and mechanic; experienced designer of labor saving tools, jigs and fixtures, gas motors, automobiles and motor-boats. Box 77, AMERICAN MACHINIST.

CONNECTICUT

Wanted—Position as general foreman; 13 years' experience; go anywhere; references furnished; married. Inquire 6 Summer St., Norwich, Conn.

ILLINOIS

Foreman capable of handling toolroom in a manufacturing plant or an independent tool shop. Box 82, AMERICAN MACHINIST.

Have had considerable experience in superintending construction of duplicating tools and assembling small machinery. Box 80, AMERICAN MACHINIST.

Designer familiar with the requirements for interchangeable manufacture; technical, practical, experienced and reliable. "L. M. N.," AMERICAN MACHINIST.

Graduate mechanical engineer with 9 years' experience as machinist and toolmaker; 4 years' mechanical drafting in or near Chicago. Box 73, AMERICAN MACHINIST.

MASSACHUSETTS

By a first class designer of automatic and special machinery. Box 74, AMER. MACH.

General foreman or superintendent; good executive and thoroughly up to date; east preferred. Box 86, AMERICAN MACHINIST.

First-class metal patternmaker, experienced on hand and molding-machine patterns, wishes position. Will go anywhere. Box 938, AMERICAN MACHINIST.

Wanted—Position as designing draftsman by a Swedish technical graduate; 27 years of age, with three years' experience in United States. Box 83, AMERICAN MACHINIST.

Position as mechanical engineer or superintendent by a technical graduate; twenty years' experience as draftsman, engineer and superintendent. Box 75, AMER. MACHINIST.

NEW JERSEY

Mechanical draftsman wishes position. Box 89, AMERICAN MACHINIST.

Up-to-date machine shop foreman desires position; best of reference; can control some machine work. Box 91, AMER. MACHINIST.

A-1 machinist and toolmaker, twelve years executive. Modern, systematic, thorough and competent in directing any class of manufacturing, toolmaking or machine work. Highest references. Box 41, AMERICAN MACHINIST.

NEW YORK

Draftsman, practical mechanic, ingenious, wants position. Box 85, AMER. MACHINIST.

Toolmaker; A-1 on very accurate work; best of references; had position as foreman. Box 84, AMERICAN MACHINIST.

Position as superintendent or factory manager by practical mechanic at salary of not less than $4000. Can buy interest in good prospect. Box 34, AMERICAN MACHINIST.

Designing draftsman; 4 years shop and office experience; technical graduate; inventive and executive ability; moderate salary; highest references. Ambitious, AM. MACH.

Six years' experience as foreman and superintendent, first class tool and instrument maker; good on estimates and contracts; desires responsible position. Box 79, AM. M.

American, 32, desires position as superintendent or master mechanic in metal goods or light machine manufacturing; high-class references. Box 68, AMERICAN MACHINIST.

Inventor and engineer; highest standing as developer and designer of machinery; man of business and character; with one concern past 10 years; wants position. Box 90, AMERICAN MACHINIST.

Mechanical engineer, gas engine expert, college graduate, with extensive experience here and abroad, wants position as superintendent, chief draftsman, representative or salesman. Box 45, AMERICAN MACHINIST.

OHIO

Position as superintendent or factory manager; interchangeable manufacturing, gray iron and brass foundry experience; salary not less than $3000; can buy interest in good prospect. Box 81, AMERICAN MACHINIST.

PENNSYLVANIA

Engineer, draftsman, mechanical, structural, 8 years. Box 71, AMERICAN MACHINIST.

Toolmaker used to close work with wide experience; also first class on experiments, wants position; goes anywhere. Kynast, Mountain Top, Pa.

Engineer and draftsman, good mathematician, experiences in general shop engineering, dies, tools, heavy machinery; A-1 references. Box 88, AMERICAN MACHINIST.

## Help Wanted

*Classification indicates present address of advertiser, nothing else.*

NEW YORK

Wanted—Manager for a small machine shop and foundry to make transmission and pulp and paper making machinery. Address with reference, experience and salary expected. Box 72, AMERICAN MACHINIST.

Foreman wanted machine department large factory. Requirements are knowledge of drill press, lathe, screw and milling machines, experience in interchangeable manufacturing.

ability to handle men, systematize and get out large variety of standard work. Box 26, AMERICAN MACHINIST.

Wanted—A thorough mechanic with practical experience in the manufacture of small interchangeabe parts; capable of determining machine capacities, proper tools, conditions, etc., to obtain maximum efficiency for piece rating; a man with experience in gun manufacture preferred. Address "Superintendent," Box 57, AMERICAN MACHINIST.

Wanted—First-class toolmaker who has had several years' experience in watch factory toolroom on master plates and sub-press die work, also experience in the manufacture of watch factory and precision tools. When replying give experience in full and state with what firms you have been employed, how long with each and on what class of work; also give age and salary expected. Box 61, AMERICAN MACHINIST.

OHIO

Wanted—By large concern in Middle States four first-class lathe hands, men capable of handling from two to six men and boys and teaching them to do good and rapid lathe work. Applicants will have good opportunity to travel as lathe demonstrators. In writing give past five years' experience. Box 33, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First class draftsman on mill construction and equipment, technical man preferred. Box 24, AMERICAN MACHINIST.


# For Sale

For Sale—Cheap before removal, one 28"x26' Fitchburg engine lathe, compound rest, etc., two Pratt & Whitney screw machines, ¾ or ⅞ through spindle, and 7x36 and 9x36 precision bench lathes. J. Bieser, Springfield, Ill.

For Sale—A 10x10 center crank Watertown automatic engine, revolutions 325, rated at 60 h.p.; in good running condition and used in brewery for electric light purposes; too small for our present requirements; will sell cheap. Address Thieme & Wagner Brewing Co., Lafayette, Ind.


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Carborundum Co., Niagara Falls, N. Y.
Dcikinson, Thos. L., New York.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

**Agents, Foreign Machinery**

Churchill & Co., Chas., London, Eng.
C. I. F. Co., Mew York.

**Air Lifts**

Ingersoll-Rand Co., New York.

**Alundum**

*See Grinding Wheels.*

**Arbor Presses**

Barnes Co., W. F. & John, Rockford, Ill
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

**Arbors**

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

**Balancing Ways**

Bowsher Co., N. P., South Bend, Ind.

**Barrels, Steel**

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

**Barrels, Tumbling**

Globe Machine & Stamping Co., Cleveland, O.

**Bars, Boring**

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

**Bearings, Ball and Roller**

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.

**Belt Dressing**

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

**Belt Fasteners**

Bristol Co., Waterbury, Conn.

**Belt Filler**

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

**Belt Lacing Machine**

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

**Belt Shifters**

The L. & D. Co., Boston, Mass.

**Belting, Leather**

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

**Benches, Work**

Manufacturing Equipment & Engineering Co., Boston, Mass.

**Bending Machinery, Hydraulic**

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

**Bending Machinery, Plate**

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

**Bending Machinery, Power**

Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

**Bending Tools, Hand**

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

**Blanks, Nuts and Screw**

Electric Welding Products Co., Cleveland, Ohio.
Whitman & Barnes Mfg. Co., Chicago, Ill.

**Blocks, Chains**

*See Hoists, Hand.*

**Blocks, Die**

Nicholson & Co., W. H., Wilkes-Barre, Pa.

**Blowers**

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

**Blue Print Machines**

General Electric Co., New York.

**Bolt and Nut Machinery**

Acme Machry. Co., Cleveland, O.
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Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manville Mach. Co., E. J., Waterbury, Conn.
McCabe, J. J., New York.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.
National Machinery Co., Tiffin, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

**Bolt and Nut Machinery** —*Continued.*

Wiley & Russell Mfg. Co., Greenfield, Mass.

**Bolt Heads**

Lang & Co., G. R., Meadville, Pa.

**Bolts and Nuts**

Electric Welding Products Co., Cleveland, Ohio
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

**Bone for Case Hardening**

Rogers & Hubbard Co., Middletown, Conn.

**Books, Technical**

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Sames, Chas. M., Jersey City, N. J.

**Boosters**

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Boring and Drilling Machines, Horizontal**

Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co, New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

**Boring and Turning Mills, Vertical**

American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Philadelphia, Pa.
Vandyck Churchill Co., New York.

**Boring Tools**

Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co. Chicago, Ill.

**Boxes, Tote**

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

**Box Tools, Roughing**

Bardons & Oliver, Cleveland, O.

**Brazing**

Industrial Oxygen Co., New York,

**Broaching Machines**

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

**Bulldozers**

Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

**Cabinets, Tool**

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

**Calipers**

Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

**Cams**

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

**Carborundum**

*See Grinding Wheels.*

**Carborundum Paper and Cloth**

Carborundum Co., Niagara Falls, N. Y.

**Case-Hardening**

American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

**Castings, Brass and Bronze**

Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.

**Castings, Die Molded**

Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

**Castings, Iron**

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Taylor & Fenn Co., Hartford, Ct.
Walker & Pratt Mfg. Co., Boston, Mass.

**Castings, Steel**

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Mass.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo

**Cast Iron Brazing**

Industrial Oxygen Co., New York.

**Cement, Cast Steel**

Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O.

**Centering Machines**

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

**Centers, Planer**

Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

**Chains, Driving**

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

**Chisels, Cold**

Whitman & Barnes Mfg Co., Chicago, Ill.

**Chucking Machines**

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
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Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

**Chucks, Drill**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co. R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Lancaster Knife and Machine Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

**Chucks, Lathe**

Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

**Chucks, Planer**

Bartlett, E. E., Boston, Mass.
Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

**Chucks, Split**

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

**Circuit Breakers**

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Clamps**

Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn N. Y

**Clocks, Watchman's**

Hardinge Bros., Chicago, Ill.

**Clutches, Friction**

Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn
Niles-Bement-Pond Co., New York.

**Coal Handling Machinery**

Link-Belt Co., Philadelphia, Pa.

**Compound, Core**

Obermayer Co., S., Cincinnati, O.

**Compound, Pipe Joint**

Dixon Crucible Co., Joseph, Jersey City, N. J.

**Compressors, Air**

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

**Compressors, Gas**

Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York

**Cones, Friction**

Evans Friction Cone Co., Newton Centre, Mass.

**Connecting Rods and Straps**

Electric Welding Products Co., Cleveland, Ohio.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

**Contract Work**

Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manville Bros. Co., Waterbury, Conn
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

**Controllers and Starters, Electric Motor**

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Conveyors, Automatic**

Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

**Coping Machines**

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

**Corundum**

*See Grinding Wheels.*

**Cotters**

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

**Counterbores**

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

**Counters, Revolution**

Root Co., C. J., Bristol, Conn.
Schuchardt & Schutte, New York.
Veeder Mfg. Co., Hartford, Ct.

**Countershafts**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.

**Countershafts**—*Continued.*

Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, Ohio.
Smith Countershaft Co., Boston, Mass.

**Countershafts, Friction**

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

**Countershafts, Speed Changing**

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

**Counting and Printing Wheels**

Franklin Mfg. Co., H. H., Syracuse, N. Y.

**Couplers, Hose**

Ingersoll-Rand Co., New York.

**Couplings, Shaft**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

**Cranes**

Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

**Crank Pin Turning Machines**

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

**Crank Shafts**

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

**Crucibles**

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

**Crushers**

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

**Cupolas and Ladles, Foundry**

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

**Cups and Covers, Oil**

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

**Cups, Grease**

Lunkenheimer Co., Cincinnati, O.

**Cutters, Milling**

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

**Cutting-off Machines**

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks., Inc., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

**Cutting-off Tools**

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

**Diamond Tools**

American Emery Wheel Co., Providence, R. I.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

**Dies, Sheet Metal**

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co. Cleveland, O.
Manville Bros Co., Waterbury, Conn

**Dies, Sub-Press**

Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

**Dies, Threading, Opening**

Allen Co., Chas. G., Barre, Mass.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

**Drawing Boards and Tables**

Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.

**Drawing Materials**

Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

# High Grade Driving Chains

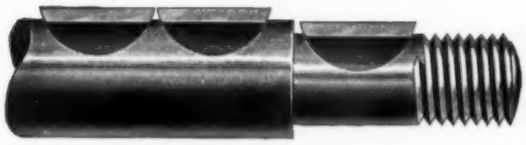
For Machinery, Automobiles, Bicycles, etc.

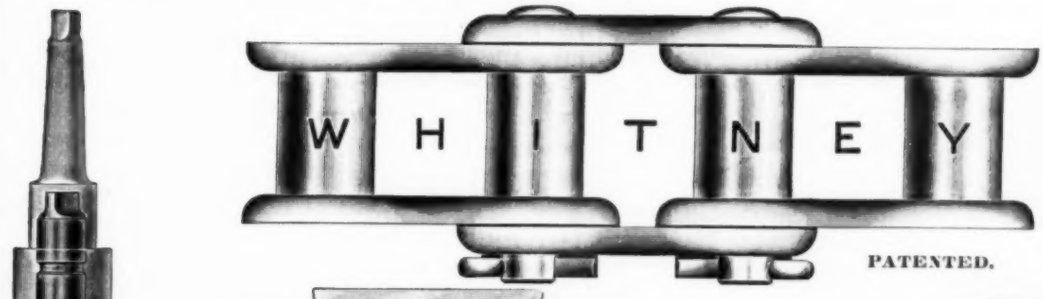
Hand (feed) Milling Machines.

20-Inch Water Tool Grinders.

Keys and Cutters for The Woodruff Patent System of Keying.

"Presto" Chucks, Collets and Friction Tapping Devices.



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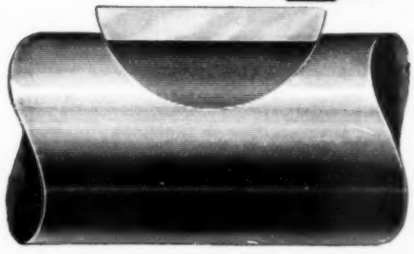


## The Whitney Mfg. Co.,

**Hartford, Conn., U. S. A.**

**Drafting Machines**

Universal Drafting Mach. Co., Cleveland, O.

**Drilling Machines, Bench**

American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

**Drilling Machines, Boiler**

American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

**Drilling Machines, Multiple Spindle**

Allen Co., Chas. G. Barre, Mass.
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

**Drilling Machines, Portable**

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

**Drilling Machines, Radial**

American Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

**Drilling Machines, Turret**

Fay Machine Tool Co., Phila., Pa.
Niles-Bement-Pond Co., New York.

**Drilling Machines, Upright**

Allen Co., Chas. G., Barre, Mass.
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Co., Tool Co. Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

**Drills, Center**

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

**Drills, Electric**

Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.
Van Dorn Elec. Mfg. Co., Cleveland, Ohio.

**Drills, Hand**

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

**Drills, Pneumatic**

Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

**Drills, Rail**

Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

**Drills, Ratchet**

Armstrong Bros. Tool Co., Chicago, Ill.
Cleveland Twist Drill Co. Cleveland. O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.

**Drills, Ratchet—*Continued.***

Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

**Drills, Rock**

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

**Drill Speeder**

Graham Mfg. Co., Providence, R. I.

**Drying Apparatus**

Sturtevant Co., B. F., Hyde Park, Mass.

**Dynamos**

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Electrical Supplies**

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cincinnati, O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Electrically Driven Tools and Machinery**

American Tool Works Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, Ohio.
Western Electric Co., Chicago, Ill.

**Elevators**

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

**Emery Wheels**

*See Grinding Wheels.*

**Emery Wheel Dressers**

American Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

**Enclosures, Tool-Room**

Hart & Cooley Co., New Britain, Conn.

**Engineering Appliances**

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

**Engineers, Mechanical and Electrical**

Crocker-Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.

**Engines, Gas and Gasolene**

Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.

**Engines, Motor**

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

**Engines, Steam**

Sturtevant Co., B. F., Hyde Park, Mass.

**Engraving Machinery**

Gorton Mach. Co., Geo., Racine, Wis.

**Exhaust Heads**

Sturtevant Co., B. F., Hyde Park, Mass.

**Exhibition, Machinery**

Philadelphia Bourse, Phila., Pa.

**Expanders, Tube**

Nicholson & Co., W. H., Wilkes-Barre, Pa.

**Export**

Churchill & Co., Chas., London, Eng.
C. I. F. Co., New York.

**Eyelet Machinery**

Manville Bros. Co., Waterbury, Conn.

**Factory Equipment**

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

**Fans, Electric**

Crocker-Wheeler Co., Ampere, N. J
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Fans, Exhaust**

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

**Files and Rasps**

Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nash Co., Geo., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

**Filler, Iron**

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

**Filing Machines**

Henry & Wright Mfg. Co., Hartford, Conn.

**Fittings, Iron**

National Tube Co., Pittsburg, Pa.

**Flexible Shafts**

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

**Forges**

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burk Machy. Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

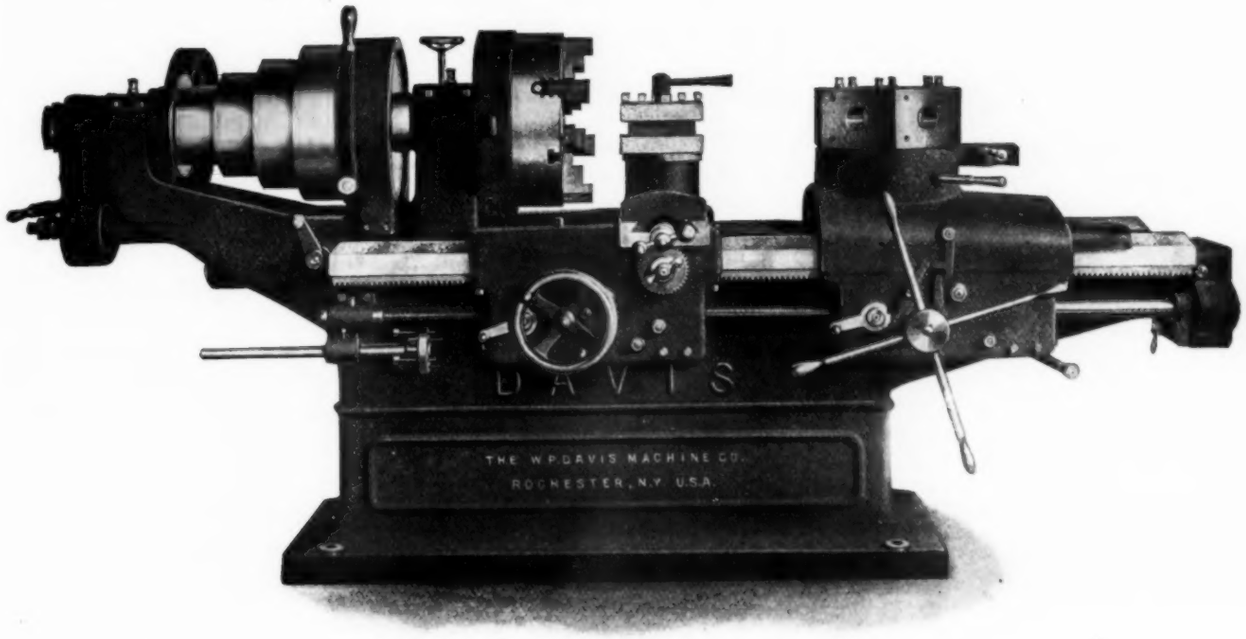
**Forgings, Drop**

Billings & Spencer Co., Hartford Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn
Page Storms Drop Forge Co., Springfield, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

**Forgings, Steel**

Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.

# ACCURATE MACHINE TOOLS.




## 26-Inch Turret Head Boring, Forming and Turning Lathe

**With Triple Gear and Geared Friction Head.**

This machine is desirable in any manufacturing plant having a large number of pieces to finish of a given size. Six or more operations can be performed on the piece before removing from the chuck, including boring, facing, forming and turning as well as threading, and cuts all threads from 2 to 32 to the inch, with either the carriage or the ram. All gears are cased as shown by cut.

The machine is provided with a friction head also a positive drive with the back gear. The triple gear meshes into the face plate. (This does not show, being covered with a shield.)

The lathe is provided with six instantaneous quick change feeds, and the spindle has twenty-four speeds, has an automatic stop for each face of the turret, and any face can be tripped at any point desired in the length of the bed, which is a decided advantage. The carriage has a turret mounted on a cross slide, so that facing as well as turning can be done.

There is an automatic trip on the carriage as well, by which a stop is obtained on each of the four sides of the turret.

The machine throughout is made for heavy, continuous service, and is well adapted for the work it is intended.

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